NINTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1916-1917

SUPPLEMENT TO THE REPORT OF
THE DEPARTMENT OF AGRICULTURE

PRINTED BY ORDER OF THE LEGISLATURE

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1917

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Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1916-1917.

To the Honourable J. E. Caron, M.P.P.,
Minister of Agriculture,
Quebec.

Sir:—

I have the honour to present herewith the Ninth Annual Report of the Quebec Society for the Protection of Plants from Insects and Fungous Diseases, containing proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 23rd of March, 1917.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

J. M. SWAINE,
Secretary-Treasurer.

Ottawa, 1917.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

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President—Professor W. Lochhead, Macdonald College.

Vice-President—Mr. Auguste Dupuis, Director of Fruit Experiment Stations, Village des Aulnaies, Que.

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Delegates to the Ontario Entomological Society—Dr. J. C. Chapais, St. Denis, Que., and Father Leopold, La Trappe.

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Jenkins, M. H. ..... Ottawa, Ont.
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Kieffer, M. H. ..... Forest Service, Que.
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Levasseur, Rev. Paul ..... Ste. Anne de la Pocatière
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MacClement, Dr. W. T. ..... Queen's University, Kingston, Ont.
Maheux, G. ..... Provincial Entomologist, Que.
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Pacquet, Jos. ..... Ste. Anne de la Pocatière
Piché, G. C. ..... Chief Forester, Quebec
Raymond, A. C. ..... La Trappe, Que.

Reid, Peter.....Chateauguay Basin, Que.
Reid, B. T.....Woodstock, N.B.
Robinson, J. M.....Kentville, N.S.
Roy, H.....Forest Service, Quebec.
Roy, H. B.....Sudbury, Ont.
Sanford, P. Clayton.....Macdonald College
Savoie, Narcisse.....Dept. of Agr., Quebec
Simard, J.....Dept. of Agr., Quebec
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Swaine, J. M.....Entomological Branch, Dept. of Agr., Ottawa
Vanderleck, J.....Macdonald College
Victorin, Rev. Bro.....Longueuil, Que.
Winn, A. F.....32 Springfield Ave., Westmount

HONORARY MEMBERS

James W. Robertson, Esq., LL.D., C.M.G., Ottawa.
Hon. J. E. Caron, M.P.P., Quebec.
Hon. Jules Allard, M.P.P., Quebec.
F. C. Harrison, D.Sc., Macdonald College.
Rev. Canon Huard, D.Sc., Quebec.
Rev. Father Superior, La Trappe.
Rev. Father Superior, Ste. Anne de la Pocatière.

FINANCIAL STATEMENT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS FROM INSECTS AND FUNGOUS DISEASES, 1916-1917

Receipts

Brought forward	$375.58
Interest on Deposit to December 30, 1916	7.25
	$382.83

Disbursements

Expenses of members and the evening lecturer to the annual meeting, 1916	$56.62
Expenses of Delegates to Meetings of Allied Societies in 1916	37.00
Office assistance	10.00
Express and postage	28.10
Secretary	50.00
Balance, cash on hand, March 23, 1917	201.11
	$382.83

J. M. SWAINE, Secretary-Treasurer.
WM. LOCHHEAD, President.

Auditor:

E. M. DUPORTE.

NINTH ANNUAL REPORT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

Report of the Winter Meeting

The Ninth Annual Meeting of the Quebec Society for the Protection of Plants was held in the Biology Building, Macdonald College, on Friday, March 23, 1917. There was a large attendance of members, representing many parts of the Province. Dr. W. A. Riley and Dr. F. W. Barrus, both of Cornell University, were the guests of the Society and were the chief speakers at the Convention.

Business Meeting

The Annual Business Meeting was opened by the President, Professor Lochhead, at 2 p.m. There were present: Dr. Harrison, Professor Wm. Lochhead, Professor W. P. Fraser, Dr. Hamilton, P. I. Bryce, E. M. DuPorte, J. Vanderleck, of Macdonald College; Dr. J. C. Chapais, St. Denis; G. C. Piché, G. Maheux and M. H. Kieffer, Quebec; Father Leopold, La Trappe; Dr. Corcoran, Loyola College; A. F. Winn, Dr. R. Campbell and G. E. Moore, Montreal; R. F. Cummings, Maisonneuve; Dr. C. G. Hewitt, H. T. Gussow, C. E. Petch, C. B. Hutchings and J. M. Swaine, Ottawa.

The minutes of the last meeting, March 14, 1916, were read and approved.

The report of the treasurer was read and accepted.

The following officers were elected for the ensuing year:—

PRESIDENT—Professor W. Lochhead, Macdonald College.

VICE-PRESIDENT—Mr. Auguste Dupuis, Director of Fruit Experiment Stations, Village des Aulnaies, Que.

SECRETARY-TREASURER—Mr. J. M. Swaine, Assistant Entomologist for Forest Insects, Entomological Branch, Ottawa.

CURATOR AND LIBRARIAN—P. I. Bryce, Assistant in Biology, Macdonald College.

DIRECTORS—Rev. Dr. Thomas Fyles, Ottawa; Father Leopold, La Trappe; Bro. Victorin, Longueuil; Prof. Fontanel, Montreal; G. Maheux, Quebec; Messrs. A. F. Winn, Montreal; G. Chagnon, Montreal; W. P. Fraser, Macdonald College; G. Bouchard, Ste. Anne de la Pocatière.

AUDITORS—E. M. DuPorte and Dr. D. W. Hamilton, Macdonald College.

DELEGATE TO THE ROYAL SOCIETY OF CANADA—Professor W. Lochhead.

DELEGATES TO THE ONTARIO ENTOMOLOGICAL SOCIETY—Dr. J. C. Chapais and Rev. Father Leopold.

Letters of regret for inability to attend the meeting were received from Rev. Dr. Fyles, Ottawa and Rev. Canon Huard, Quebec.

It was decided to continue for another year the usual grants from the Society's funds for expenses in connection with special investigations of insects and fungous diseases in the Province, and for expenses incurred in the preparation of the lists of insects and fungi.

The List of Coleoptera of the Province of Quebec prepared by Mr. G. Chagnon, and accepted for publication at the last Annual Meeting, was reported ready for publication. The manuscript had been retained by the author for revision.

It was decided to hold the summer meeting of the Society at a place and date to be selected later by the President and Secretary.

The executive was granted $25 to help towards the entertainment of the delegates of the Ontario Entomological Society at its annual meeting in November at Macdonald College.

The Honourable J. E. Caron, Minister of Agriculture; Hon. Jules Allard, Minister of Lands and Forests; Rev. Canon Huard, of Quebec; Dr. F. C. Harrison of Macdonald College; the Rev. Fathers Superior of the College at Oka and Ste Anne de la Pocatière were elected unanimously Honorary Members of the Society.

GENERAL SESSION

The General Session of the Ninth Annual Meeting was opened at 3 p.m. by the President, Professor Lochhead, in the lecture room of the Biology Building, Macdonald College. A large number of delegates and many students of Macdonald College were present at the meeting.

Dr. Harrison welcomed the delegates to the College, and in a short address expressed his appreciation of the work of the Society. The chief paper of the afternoon was an illustrated address by Dr. F. W. Barrus, of Cornell University, on Potato Diseases. Dr. Barrus dealt chiefly with the physiological diseases of potatoes, and gave a very interesting and valuable account of these imperfectly understood troubles of the potato grower. The paper is printed in full in the Report.

The evening lecture was given by Dr. W. A. Riley, of Cornell University, on "Animal Parasites and Rural Sanitation." Dr. Riley's most instructive and interesting address dealt with one of the most important aspects of rural sanitation; it was well illustrated and is a valuable contribution to the literature of our Society.

The Summer Meeting

The Summer Meeting of the Society was held on September 7, at La Trappe in co-operative sessions with the Quebec Pomological Society. The morning was devoted to excursions through the orchards and gardens of the Trappist fathers for the study and collection of insects and fungi, and the afternoon to discussions of the life-histories, habits, and control of the species that had been collected. The great success of the outing was largely due to the hospitality of the Trappist fathers. The members of the Pomological Society present at these sessions were unanimous in declaring that such excursions and discussions were most valuable and helpful. Prof. W. P. Fraser had charge of the collection of specimens of plant diseases, and Mr. E. M. DuPorte that of insect pests.

PRESIDENT'S ADDRESS

MASTERPIECES OF AMERICAN ECONOMIC ENTOMOLOGY

By W. Lochhead, Macdonald College.

The purpose of this paper is to discuss some of the publications of work of great merit done by economic entomologists of America, which I am designating by the term "masterpieces." In these days of many workers and many bulletins one is apt to focus his attention over much on recent publications and to overlook the older ones. Aware of my own failing in this regard I thought that on an occasion of this kind a review of some of the older works on Economic Entomology would be not only interesting but also profitable, for I am convinced that we can learn a great deal in methods of work and presentation from a study of some of the masterpieces which too frequently lie neglected on our shelves. The criteria used in the selection were: (1) the completeness of the investigations; (2) the economic value of the investigations; and (3) the literary value of the publication.

The progress of economic entomology during the last ten years has widened our conception of the term "monographic completeness." The life-history of an insect involves not only a close study of the embryonic development and subsequent metamorphoses but a study of its relations to other organisms and to external factors. In other words, the ecological relations of insects are more closely studied than formerly, and this study demands a knowledge of and the application of biological processes and principles. The problems of inter-relations between insects and plants, between insects and birds, between insects and their parasites, between insects and disease, are very important from an economic standpoint, and their solution, often most difficult, is engaging the attention of many workers.

It is scarcely to be expected that the selection of the masterpieces I have made will meet with the approval of every person who is acquainted with the literature of economic entomology. The personal equation enters largely into a selection of this kind as in other matters, for I must confess that it is difficult to adjudge the merits of works apart from the men themselves. Every one of us is in some degree a hero-worshipper, no matter how much he may disclaim the title, and this mental attitude precludes an absolutely correct and fair judgment of the relative merits of the works of men even in the field of economic entomology.

Moreover, the selection was no easy task on account of the existence of a very large number of publications of first-class merit. Most of these, however, were ruled out, after careful consideration, on the ground of incompleteness. For example, Comstock's published works on scale insects and wireworms are most valuable, as they laid a solid foundation for future investigations. They cannot, however, claim monographic completeness of treatment. Howard and Marlatt's San José Scale is most thorough in so far as it goes, but the last word was not said. Much has been added to our knowledge of the insect since its publication. Osborn's "Insects affecting Domestic Animals" is an admirable compendium of information, but it must be confessed that much investigation requires to be done before our knowledge of these insects is complete.

Perhaps no insect has received more attention than the Codling Moth, yet it is difficult to choose a single publication dealing with this insect that can be called monographic. The bulletins of Slingerland, Simpson, Hammar, Jenne and Sanderson are comprehensive and deal very fully with the life-history stages and their variations due to climatic changes. The three bulletins on "Life-history Studies on the Codling Moth in Michigan" and "Life-history of the Codling Moth in N.W. Pennsylvania" by A. G. Hammar, and "The Codling Moth in the Ozarks" by E. L. Jenne are undoubtedly the most complete that have yet appeared, but they are more or less localized in their observations. We are still awaiting a monographic report of this insect, one that will gather together all the scattered fragments of regional observations and discuss comprehensively the anatomy, embryology, parasitism, hibernation, climatic and other ecological factors, and modes of control.

Within recent years excellent bulletins have appeared, but most of them might properly be called "reports of progress," as they do not presume to deal exhaustively with all phases. Some of the most suggestive of these have come from the Illinois State Experiment Station, under the direction of Professor Forbes. These are:—

Bul. 134. "Insect Pests of Clover and Alfalfa," by Folsom.

Buls. 130-1. "Corn Root Aphis and Corn Root Ant," by Forbes.

Buls. 116. 186-7. "May Beetles and White Grubs," by Forbes.

The House Fly has claimed much attention of late years, and very full information has been gathered regarding its anatomy, breeding habits, feeding habits, and its relation to disease in Howard's and Hewitt's works. Many data, however, are required with regard to hibernation, climatic control and habits before it can be said to be exhaustively treated.

The bulletins on the "Chinch Bug" by F. M. Webster (Bul. 15), and the "Hessian Fly" by Herbert Osborn (Bul. 16), published in 1898 by the U. S. Division of Entomology, deserve mention here. The authors deal with economic insects of great importance in a monographic form, and in many particulars nothing new has been added.

Regarding the habits of the Chinch Bug the most recent investigations of Forbes have yielded information of much value, while those of Webster have enabled us to control more effectively the Hessian Fly. Neither bulletin, however, has anything to tell us regarding the embryology of the insect treated.

Works Selected as Masterpieces

Basing the selection of masterpieces on the three criteria already mentioned, I have limited the works entitled to such honour to "The Rocky Mountain Locust" by Riley, Packard and Thomas; "The Gypsy Moth" by Fernald and Forbush; "The Periodical Cicada" by Marlatt; "The Mexican Cotton Boll Weevil" by Hunter and Pierce; and "The Spring Grain Aphis or Green Bug" by Webster and Phillips.

"The Rocky Mountain Locust" by Riley, Packard and Thomas

This report of the U. S. Entomological Commission is in two volumes, the first bearing the date 1877 and the second 1878-1879. As one looks through these two large volumes with their wealth of observations, their luminous discussions of the habits and movements of the insect, and the large number of well-executed maps and illustrations he is amazed at their thoroughness and fulness of treatment. They represent the best efforts of three master-workers—each a specialist in his own line. A minute of the first meeting in Washington after their appointment gives the division of labor. Each was assigned a region for investigation. In addition, "to Mr. Riley were assigned Biology and Natural History, Invertebrate Enemies and Parasites (Insects, etc.), Remedies and Devices for the Destruction of the Locust; to Mr. Packard, Anatomy and Embryology; to Mr. Thomas, Geographical distribution, Enemies not entomological, Agricultural Bearings of the Subject; and to Packard and Thomas conjointly, Connection of Meteorological Phenomena with the Migrations."

The task was undoubtedly a large one, nevertheless it was well done. No better discussions of the relations of the locust and its ravages to agriculture, of the laws governing the migrations of locusts, and of the influence

of meteorological conditions on the development and migrations of locusts have appeared in entomological or biological literature.

The study of other species of locusts is a good one, while the anatomy and histology of the locust are comprehensively treated. It is interesting to note the assistance given by Dr. C. S. Minot, J. H. Emerton, E. Burgess and J. S. Kingsley.

This great work is monographic in its completeness, deals with a most important economic problem, and is written in a charming style. It is entitled to rank among the first of the great masterpieces of American economic entomology.

"The Gypsy Moth" by Forbush and Fernald

In my judgment "The Gypsy Moth" by Forbush and Fernald, published in 1896 under the direction of the State Board of Agriculture of Massachusetts, is entitled to a place among the masterpieces of American economic entomology. Mr. Forbush's contribution deals with the introduction of the moth into New England, its increase and spread up to 1894, the efforts made to destroy it, and its natural enemies. Dr. C. H. Fernald describes its injuries in Europe, and the methods used there to control it; also the life-history in all its stages, its habits during these stages, its internal anatomy, its natural enemies, and the effects of various insecticides on the larvæ. The illustrations, some from photographs taken in the field and others from drawings of anatomical features, are excellent. The bibliography is very exhaustive.

During the twenty years since its publication little new information has been added to that given in the work. It is quite true that the great experiment of the introduction of foreign parasitic and predaceous insect enemies was launched a few years after the appearance of Forbush and Fernald's publication, but the results do not detract from its monographic completeness. "The Gypsy Moth" stands out as a masterpiece for its thoroughness, completeness and clearness, and in after years when things will be seen in a truer perspective it will in all probability be looked upon as an entomological classic.

"Mexican Cotton-Boll Weevil" by Hunter and Pierce

This work, published in 1912, is sub-entitled "A Summary of the Investigations of this Insect up to December, 1911." The investigations were begun in 1895 and were carried on continuously by a large corps of trained workers

composed of state officers of Texas, Louisiana, Mississippi, Alabama, Arkansas and Oklahoma, and agents of the Bureau of Entomology in charge of Hunter, Pierce and Hinds.

The results, being a joint product of many workers, are unusually complete, and all phases of the situation caused by the weevil are traversed very fully. Perhaps no other insect has received so much careful study. In addition to the detailed studies of the various stages of its life-history in which observations are recorded over a large area, œcological problems relating to hibernation, climatic influences, food habits, tropisms, plant control, natural control, parasites and methods of repression are discussed at length. An interesting series of observations relate to *proliferation*, the reaction of the tissues injured by the egg puncture or the larva. A mass of new cells form about the injured tissue enclosing the larva and the pressure induced is often sufficient to kill the larva and even the adult.

One of the most valuable and suggestive features of this bulletin for the economic entomologist is the description of the methods of study and investigation used in getting information regarding the various phases of the problem.

Considering, then, the character, number, importance and monographic completeness of the investigations carried out, we have no hesitation in ranking Hunter and Pierce's "Mexican Cotton-Boll Weevil" among the masterpieces of recent economic entomology.

"The Periodical Cicada" by C. L. Marlatt

This bulletin (71) of the Bureau of Entomology, U. S. Department of Agriculture, was published in 1907 and is a revision of bulletin 14, published in 1898. To my mind it is unusually replete with information regarding the habits and life-history of the insect, and, so far as I know, little of importance that is new has been added since its publication ten years ago.

The Periodical Cicada, also frequently called the Seventeen-Year Locust, but improperly as it is not a locust at all, has an unique life-history inasmuch as it spends thirteen or seventeen years underground in nymphal condition. One race or sub-species has a thirteen-year nymphal period, and is mostly confined to the Southern States, while the other and more common race has a seventeen-year period and occurs mostly in the Northern States. The adults do not appear at the same time or in the same year; on the other hand they appear as *broods* in different *years*, each brood "being limited to well-defined districts, and each reappearing at the proper intervals with absolute regularity." Altogether twenty-one broods "have been

differentiated and carefully studied, chronological records collected and the limits of distribution fairly well determined."

Marlatt's work deals not only with the appearance of the different broods in the different districts, so that it is known when any particular brood will appear in a district, but also with the structure, transformations, feeding habits, nature of injuries, natural enemies, and methods of control.

Although not one of the great masterpieces "The Periodical Cicada" is, I consider, a work of more or less monographic completeness. It lacks some of the more modern features of a monograph, namely the embryological development and the anatomical structure of the different stages of the insect.

"The Spring Grain Aphis or 'Green Bug' " by Webster and Phillips

Perhaps no family of insects has received greater attention in recent years than the Aphididae, and as a result several very carefully prepared bulletins have been published. One of the first and most complete of such aphid bulletins was prepared by F. M. Webster and W. J. Phillips of the U. S. Bureau of Entomology and issued in 1912 as Number 110. Viewed from the two standpoints of completeness and economic importance the bulletin stands high in my estimation. Every phase of the life-history of the Spring Grain Aphis is dealt with very fully, and a complete record is kept of the number of viviparous and oviparous generations and the number of individuals of each generation. The problems of diffusion and parasitism are treated satisfactorily, while a new feature is introduced when a thorough investigation is given of the embryological development.

Later Aphis publications of great value are:

"The Oat Aphis," by J. J. Davis, (Bul. 112) 1914.
"The Yellow Clover Aphis," by J. J. Davis, (Tech. Ser. 25) 1914.
"The Pea Aphis," by J. J. Davis (Bul. 276) 1915.
"Woolly Apple Aphis," A. C. Baker, Rept. 101, 1915.
"Apple Aphids," A. C. Baker.
"Apple Aphids," Parrott, N. Y. Agr. Exp. Stn.
"Apple Aphids," Matheson, Cornell Exp. Stn.
"Apple Aphids," Patch, Maine Exp. Stn.
"Cabbage Aphis," Herrick, Cornell Exp. Stn., 1911.

The absence of Canadian works among the masterpieces of economic entomology selected requires some explanation, perhaps. Canada has been tardy in her recognition of the importance of the study of economic entomology, and the meagre aid given by the federal and provincial governments until recent years has prevented the prosecution of investigations that require close continuous observations and experimentation for a series of years. The most her entomologists could do, working as they did under unfavorable conditions, was to solve minor problems and to record observations that would be of value to later workers. Of late years, however, many valuable bulletins have been published, and the probability is that in the near future masterpieces will be produced which will rival those mentioned in the preceding paragraphs.

REPORT OF DELEGATE TO THE ONTARIO ENTOMOLOGICAL SOCIETY CONVENTION

Held at Guelph, November 2nd and 3rd, 1916.

Father Leopold, Oka Agricultural Institute

Dr. J. C. Chapais notified me that illness would prevent him from accompanying me, as usual, on this trip to Ontario to represent you at the annual meeting of the Ontario Entomological Society held at Guelph. It was all the more interesting to me as I was to assist at a meeting presided over by one of the most distinguished members and entomologists of this Society in the person of Mr. A. F. Winn, of Westmount, P.Q. Although the only delegate I was sure to be in familiar and distinguished company, besides mentioning also the presence of our own president at the meeting, Prof. W. Lochhead.

Unfortunately I lost all the notes I had taken of this splendid meeting in the fire which ruined our Monastery and Church on the 27th of December last, and you will excuse me for giving you such a poor report. However, as a fruit-grower especially, I shall try to give you some details of the discussions on Dust Spraying which was the subject of a paper by Professor L. Caesar of the Ontario Agricultural College.

Among the visiting members present whom I should mention were the following: Dr. L. O. Howard, Chief of the Bureau of Entomology, Washington, D. C.; Prof. P. J. Parrott, Geneva, N.Y.; Prof. E. M. Walker, University of Toronto; Prof. W. Lochhead, Macdonald College, Que.; Prof. W. H. Brittain, Truro, N.S.; Dr. C. Gordon Hewitt, Messrs. A. Gibson, J. M. Swaine, of the Entomological Branch at Ottawa, etc.

On Thursday morning a meeting of the Council was held, at which among other matters, a recommendation was made that Mr. John D. Evans, of Trenton, Ont., a past President of the Society and a most active member for many years, should be elected a Life Member, which was done subsequently at the general meeting. It was also decided to hold the next annual meeting at Macdonald College, and if possible, to go over and pass an afternoon at the Oka Agricultural Institute, La Trappe, Que.

In the afternoon, the members met in the Entomological Lecture Room in the Biological Building, under the chairmanship of Mr. Winn. The proceedings commenced with the presentation of the reports of the Council and the various officers and branches of the Society, followed by

the reading of papers and the election of officers, a list of whom you will find in the annual report of the Entomological Society. Let me state that Mr. Winn was elected to occupy the Presidential chair for a second term.

The open meeting was held on Thursday evening in the auditorium of the Massey Hall, and we were particularly fortunate in having, as lecturer for the occasion, Dr. L. O. Howard, Chief of the Bureau of Entomology of the U.S. Department of Agriculture. Dr. Howard has made a special study of the "Carriage of Disease by Insects" for many years and he gave us in a very interesting lecture, the summary of his knowledge on this subject, dealing with the diseases carried by flies, etc., which cause fevers, etc. The evening was greatly enjoyed by the members present, besides many of the staff and students of the College and Macdonald Institute. Lantern slides permitted us to follow more closely this interesting lecture. Dr. Howard was warmly welcomed and a hearty vote of thanks was proposed by Dr. C. G.Hewitt and seconded by Prof. W. Lochhead for his kindness in coming so far to attend the meeting and giving us such an interesting evening.

After the lecture the members were entertained at a smoker given in the students' parlor, Main Building. A students' vocal quartette contributed to the enjoyment of the members. Mr. Eric Hearle, a graduate of the College, who had recently returned from active service in France, gave us an interesting account of the problems arising from the prevalence of Pediculi and other parasites and vermin in the trenches and the means taken to alleviate the terrible sufferings caused by these pests.

Among the papers read at the meeting during the two days of the convention, let me cite here the following:

"The Naturalist in the City" by our friend the Rev. Dr. T. W. Fyles; "Dusting Fruit-trees and Grapes for the Control of Biting Insects and Diseases" by Prof. L. Caesar; "General Notes on Aphids which occur on Apple trees" by Mr. W. A. Ross; "Further Experiments with the Green Apple Bug" by Prof. W. H. Brittain; "Notes on *Physonota unipuncta*, the Sun-flower Tortoise beetle," by Mr. A. F. Winn; "Preliminary notes on the use of Repellants for Horn-flies and Stableflies on Cattle" by Mr. A. W. Baker; the very literary and interesting paper of Mr. F. J. A. Morris, "The Wood of Desire," a description of a few trips of his which we can compare to the beautiful pages of the regretted Mr. H. Fabre; "Insects as Material for Studies in Heredity" by Prof. W. Lochhead; "The Migratory Tendency of Dragon-Flies" by Prof. E. M. Walker; "The History of the Forest Tent Caterpillar and Fall Web-worm in North America" by Mr. A. B. Baird; "Three important Greenhouse Pests recently introduced in

Canada" by Mr. A. Gibson; "Camp Hygiene" by Capt. G. J. Spencer, dealing mostly with camp hygiene as conditions were dealt with in Camp Borden; "Experiments in the Control of the Apple Maggot" by Prof. W. H. Brittain; "Summary of experiments on the control of Locusts with *Coccobacillus acridiorum*" by Mr. E. M. Du Porte and J. Vanderleck; "Three Shade Tree Insects," by J. M. Swaine; "Notes on some Insects of the Season" by Mr. L. Caesar; and "Parasites of the Larch Sawfly" by Dr. C. Gordon Hewitt.

One of the most important and interesting matters brought up at the meeting was the subject of dusting, introduced by Prof. L. Caesar, who gave us an intersting and instructive paper on his experiments in the use of dust instead of liquid sprays during the season of 1916. Although one season's results are not considered absolutely conclusive, the results were very favorable as far as the work of the Provincial Entomologist was concerned. His report is here summarised:

A careful and somewhat extensive test was made on apples, plums, cherries and grapes of the new method of treating diseases and insects by dusting them with a mixture composed of 85% very finely ground sulphur and 15% arsenate of lead powder. Wherever, as in the case of grapes, an insecticide was not required the arsenate of lead was omitted. The dusting was made by means of a blower driven by a 2½ h.p. gasoline engine. The results on a block of ninety-two very large and neglected apple trees were, at the time of picking, an average of 97% of fruit free from scab and a little over 90% free from Codling Moth. On a liquid sprayed plot in the same orchard where lime-sulphur and arsenate of lead paste were used, the result was an average of 99% of the fruit free from scab, and about the same percentage free from Codling Moth as with the dust spray. Untreated orchards of the same varieties of fruit in the Niagara district where the experiments took place had an average of 40 to 50% only free from scab and 30 to 60% free from Codling Moth.

There is no doubt that wet weather washes off the dust spray much more quickly than the liquid, and under the circumstances Mr. Caesar thinks it better not to advise dusting yet, until more experiments have been made under all sorts of conditions, and his stand is certainly a wise one.

THE MANAGEMENT OF WOODLOTS

G. C. Piché, Chief of Forest Service, Quebec.

Recognizing the gradual diminution in merchantable timber, and even, in certain places, of firewood, it becomes more and more evident that it is necessary to take proper precautions for managing the forest property in a systematic fashion. The Provincial Government, controlling the greater part of our forests, has established very suitable regulations, whose execution is supervised by the members of the Forest Service. However, a certain very important part of our forest domain escapes this control. I speak here of the woodlots or private woodlands which are distributed through all the province, in all the villages, and which constitute an important part of the inheritance of our farmers.

I should say here that many of our woodlots are very well managed, and could not be handled in a better way. Consequently, the remarks which follow do not apply to these good foresters, but to those who have not heretofore considered the woodlots in a serious manner.

The proper management should be carried out so as to remove only the annual crop, that is to say, an amount of wood equal to that produced by the woodlot during the year. If one cuts more than the yearly production, what the foresters call the "increment," there results a gradual reduction of the forest capital. It is necessary to understand that often owners of woodlots are obliged to make heavy cuttings, for instance when one wishes to construct a building or to realize a certain sum of money which he requires; but with proper organization one foresees such a necessity and, instead of removing each year all the crop of wood, a certain portion is left in reserve. Just as is done in properly managed financial institutions, such as banks, the proprietor of a wood lot ought to establish a reserve fund by economies made each year. A second point to observe is to direct the cutting towards the trees which have practically reached full growth. If we consider the tree as a capital, yielding each year a certain percentage of interest, we should remove the tree when its percentage of interest, that is to say, the annual increase, falls too much below the mean, and replace it by a younger and more vigorous tree. Trees injured by storms or lightning should also be cut out each year so as to obtain all the benefit the wood can give before it deteriorates by rot. Also, those that are attacked by insects or fungi are equally exposed to destruction and ought to be removed without delay; finally, when fire sweeps over a portion of the woodlot it is necessary to hasten the removal of the injured trees in order to

obviate total loss, since the fire injured trees become centres of infection for the multiplication of boring insects.

The owner should form a definite plan of what he wishes to obtain; just as the farmer must in the springtime foresee how he will sow his different fields, so the forest owner ought to decide toward what ends he will direct the management of the different parts of his woodlot. Thus, certain portions will serve for the maple grove, on account of the poor soil and the ease with which the different parts may be reached in springtime when he goes to collect the sap. Another part, rather wet, will only serve for fir, tamarack and ash, and other parts, where the soil is dry and poor, should favour the growth of pine. In a word the forest owner should endeavour to learn, first, the different soils and the other conditions of the land, and what species of trees are most appropriate for his conditions, and in the course of the management of the woodlot he would only have to remove the trees which would retard the development of the species that he intends to favour.

Finally, when it is necessary to cut the timber, needless to say, the stumps are left as near the ground as possible, so that all the merchantable wood that the trees can give, whether in logs or otherwise, may be obtained. And the debris from the cut which is useless for fire wood should be distributed over the ground so as not to interfere too much with the circulation of the air or to constitute a fire menace. For this purpose it will only be necessary to trim off the branches from the tops so that the latter will be reduced to as small a space as possible. Then, with the heavy snowfall which we have in this province, they will be pressed close to the ground, so that they will remain wet longer and will be on that account less likely to ignite and more likely to decay rapidly.

It is evident that there is really very little extra trouble in managing a wood lot properly so that it can give the proprietor a fair revenue. Naturally, if there are places bare of trees it is of the greatest importance to plant them with suitable species, and for this purpose one can obtain from the nursery at Berthierville, Que., all the plants desired under advantageous conditions, for the Provincial Government takes great interest in the question of reforesting. The Hon. Mr. Allard, Minister of Lands and Forests, will be very pleased to see all the forest owners cover the clearings in their woodlots with judicious plantations, that is to say, with species appropriate to the local conditions. He would be glad to have all those who need advice write to the Chief of the Forest Service, Quebec, explaining to him the conditions obtaining in their woodlots, whose management they wish properly organized; the Government Forest Engineers will then furnish freely the necessary advice on the management of the plantation so as to improve and perpetuate the property.

The Forest Service can assist the forest owners in the following ways:

I. In preparing a plan of management of the woodlot.

II. In furnishing at the ordinary price the necessary plants for filling the clearings in the property.

III. In indicating the methods of cultivating the most profitable species of trees for the woodlot.

When it becomes necessary to examine the woodlot the conditions will be as follows:

The Forest Service will pay the salary of an expert who is appointed to make the examination; but the forest owner will defray the expenses of board and transportation, the estimated amount of which should be forwarded in making the application, so as to avoid misunderstandings.

It would be preferable for several neighbouring owners to unite so as to reduce the individual expenses; and from the standpoint of the Forest Service this will be very helpful, for we have only a small number of forest engineers at our disposition, and, consequently, cannot send them everywhere.

We hope that those interested will study this question seriously, since it is greatly to their advantage, and that they will profit by the assistance so generously offered by the Provincial Government, thereby increasing the interest from their property and, consequently, their income.

A FEW NOTES ON THE "PEAR TREE SLUG"

J. C. Chapais, St. Denis-en-bas

My aim in writing this paper is to give a better knowledge of the pear slug than many of those who have to suffer from its misdeeds in their orchards generally have of it.

Let us see, first, what place the pear tree slug occupies in entomological nomenclature: Phylum of *Arthropoda*, Class of *Insecta*, Order of *Hymenoptera*, Family of *Tenthredinidæ*, Genus, *Tenthredo*, *Selandria* or *Eriocampa*, Species, *Selandria* or *Eriocampa cerasi*.

It is the larva of *Selandria cerasi* that makes havoc of pear, plum and cherry trees in our orchards. As a larva and as an adult insect it is known under many names, and we will give here its various names to prevent confusion.

As a larva we find it called:

In English	In French
Cherry Tree Slug	Larve limace
Pear Tree Slug	Limace du cerisier
Slug Worm of Pear	Ver limace du poirier

As an adult insect it is called:

In English:	In French:	In Latin:
		Allantus cerasi
		Eriocampa cerasi
	Allante du cerisier	Eriocampa limacina
Cherry Saw-fly	Mouche à scie du cerisier	Eriocampoides limacina
	Tenthrède du cerisier	Selandria atra
	Sélandrie du cerisier	Selandria cerasi
		Tenthredo cerasi.

The pear slug is found on cherry, pear, plum and quince trees in our orchards, and on hawthorn, mountain-ash and sallow in the woods.

Saunders, in his "Insects injurious to Fruits" gives the following information about this insect:

"The pear slug passes the winter in the chrysalis state under ground;

the flies, the progenitors of the mischievous brood of slugs, appearing on the wing in the Northern States and Canada from about the third week in May until the middle of June. The fly is of a glossy black colour with four transparent wings, the front pair being crossed by a dusky cloud; the veins are brownish and the legs dull yellow, with black thighs, except the hind pair, which are black at both extremities, and dull yellow in the middle. The female fly is more than one fifth of an inch long, the male is somewhat smaller.

"These flies are called 'saw-flies' from the fact that in most of the species the females are provided with a saw-like appendage at the end of the body, by which slits are cut in the leaves of the trees, shrubs or plants on which the the larvae feed, in which slits the eggs are deposited. The female of this species begins to deposit its eggs early in June; they are oval and placed singly within little semicircular incisions through the skin of the leaf, sometimes on the under side and sometimes on the upper. In about a fortnight these eggs hatch.

"The newly-hatched slug is at first white, but soon a slimy matter oozes out of the skin and covers the upper part of the body with an olive-colored sticky coating. After changing its skin four times, it attains the length of half an inch or more and is then nearly full-grown. (It requires four or five weeks for the slug to make those changes of skin).

"After the last moult, it loses its slimy appearance and dark colour, and appears in a clean yellow skin entirely free from slime. In a few hours after this change it leaves the tree and crawls or falls to the ground, where it buries itself to a depth of from one to three or four inches. There the insect changes to a chrysalis, and in about a fortnight finishes its transformation, breaks open its earthen cell, crawls to the surface of the ground, and appears in the winged form.

"About the third week in July the flies are actively engaged in depositing eggs for a second brood, the young slugs appearing early in August. They reach maturity in about four weeks, then retire under ground, change to chrysalids, and remain in that condition until the following spring."

Saunders, as quoted above, says that there are two broods of the pear slug in one season, but in our orchards at Saint-Denis in Kamouraska we have never seen more than one brood, the first slugs appearing with us at the beginning of August. This covers an experience of twenty-three years.

To destroy this slimy larva it is advisable to dust freshly slaked lime on the leaves of the trees infested.

On cherry trees planted in orchards the use of arsenical insecticides is recommended, after the gathering of the fruit crop.

When the attack is very bad and the use of insecticides has been neglected, it is necessary to apply to the ground fertilizers that are readily assimilated, such as 125 lbs. nitrate of soda, 200 lbs. superphosphate and 40 bushels wood ashes (or, when the war is over 100 lbs. of muriate of potash) per acre to help the trees to recuperate.

Bibliography

"Insects injurious to fruits," William Saunders, Philadelphia, 1883.

"Manual of injurious insects," E. A. Ormerod, London, 1890.

"Le livre de la Ferme," Pierre Joigneaux, Paris, quartième édition.

CARRIERS AND DILUENTS FOR DUSTING

C. E. Petch, Hemmingford, Que.

During the past five or six years experiments have been performed comparing the dust and liquid methods of applying insecticides and fungicides. Last year this work increased enormously and good results were obtained, but there are still many objections to dusting to be overcome.

It is too early to say whether sucking insects, such as aphids, can be destroyed by dusting, but experiments have shown this method to be equal to or better than liquid sprays for most biting insects. One serious objection to dusting is the cost of materials, and it was chiefly this objection that caused me to make this preliminary study of carriers and diluents.

Dusting should be very valuable in the control of most shade-tree insects, and also on many occasions in orchards when only an insecticide is necessary. Therefore, it can be readily seen that a good carrier and diluent, at a small cost, is a very important item. Carriers should be nearly of the same specific gravity as the insecticide and fungicide used, otherwise upon standing the heaviest material will settle down in the containers. It will be seen in the following table that the source of carriers is a local one in many cases and the grower can gather and prepare his own.

Basing conclusions solely upon the notes in the following table, the best diluents and carriers are, in the order of efficiency,—talc schist, limestone, gypsum, china clay and silt.

No.	Material	Sp. Gr.	Hardness	Colour	Preparation	Where Obtainable	Approximate cost per ton	Remarks
1	Gypsum	2.3 to 2.33	1.5 to 2.0	Usually white, occasionally grey or pink.	Crushed, pulverized and bolted.	None in Quebec, Fertilizer Co.'s., or Builders' Supply Co.'s	$5.00 to $10.00	Already used successfully.
2	Barite	4.3 to 4.6	2.5 to 3.5	White to pink.	Crushed, pulverized and bolted.	Paint firms	$10.00 to $25.00	Too heavy, and expensive.
3	Talc Schist	2.6 to 2.8	1.0	White, grey or apple green.	Crushed in chaser mill and bolted if necessary.	W. E. Loonus, Sherbrooke, Que.	$4.00 to $6.00	Light and smooth, cheap, and a possible insecticide for aphids.
4	Infusorial Earth	Varies but is lighter than sulphur.	.....	Creamy white or yellowish-grey.	Found as powder; pulverized and bolted.	Lyman Limited, Montreal.	$25.00 to $65.00	Too expensive.
5	Limestone	2.6 to 2.8	3.0	Grayish	Crushed, pulverized and bolted.	Cement mills	$4.00 to $6.00	Easily obtained; should be very good.
6	Marl	Approximately 1.0	.....	White	Pulverized if necessary and bolted.	Bottom of marl lakes, numerous in Quebec.	$8.00 to $14.00	Could be obtained locally and prepared.
7	Marble Dust.	2.6 to 2.8	3.0	White	Crushed, pulverized and bolted.	Marble quarries, Philipsburg and South Stukely, Que.	$8.00 to $10.00	Probably too sharp, liable to cut foliage.
8	Hydrated Lime	.....	.....	White to cream	Quicklime, hydrated excess water evaporated; then bolted.	Builders' supply companies.	$15.00 to $30.00	Expensive.
9	Silt	.....	.....	Gray to grayish white.	Use as found or bolt if necessary after drying.	Beds of streams; stratified between sand and clay.	$3.00	Liable to be very good provided sand grains water-worn.
10	Silty Clay	Approximately 1.0	.....	Gray to grayish white.	Pulverized and bolted if necessary.	Beds of streams, stratified between sand and clay.	$3.00	Liable to be good if kept dry; lumpy if damp.
11	Marine Clay.	Approximately 1.0	.....	Gray to black	Pulverized and bolted if necessary.	Brick manufacturers	$4.00	Liable to be good if dry; lumpy when wet.
12	China Clay	Approximately 1.0	.....	White, sometimes yellow.	Washed, pulverized and bolted.	Canada China Clay Co., Transportation Bldg., Montreal.	$8.00 to $10.00	Should be very good; uniform in texture.
	Sulphur	2.05	.....	Yellow	Sold as flowers of sulphur	Insecticide Companies	$45.00	Must be finely powdered.
	Arsenate of Lead	.....	.....	White	Sold as powder	Insecticide Companies	$460.00	.....

CABBAGE INSECTS

By Arthur Gibson, Chief Assistant Entomologist,

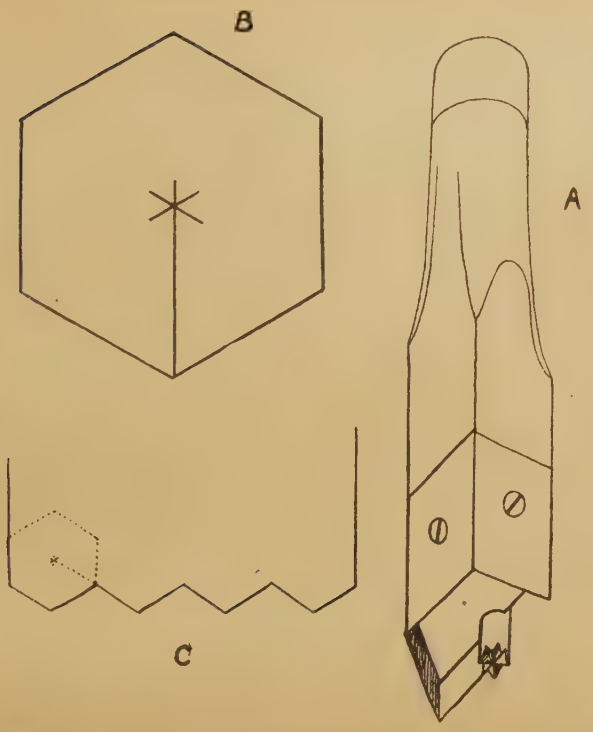
In Charge of Field Crop Insect Investigations, Department of Agriculture, Ottawa.

There are a number of important insects which almost every year effect more or less damage to cabbages in the Province of Quebec and, at the request of the Secretary of the Society, I have assembled such information concerning them, which I have considered would be of value to farmers and gardeners. No attempt has been made to discuss the insects themselves or their life-histories, the idea being to present the remedial measures which in our investigations, covering a number of years, we have found of most service.

The Cabbage Root Maggot, *Phorbia brassicae* Bouché

The Cabbage Maggot Fly resembles the common house fly but is rather smaller and more slender. About the time cabbages and cauliflowers are set out, or when radishes and turnips appear above the ground, the flies may be seen flying close to the ground depositing small, white, elongated eggs on the stems of the plants or adjacent thereto. The eggs hatch in a few days and the small white maggots at once burrow into and destroy the roots. Injury may continue from May until autumn.

Remedies.—Cabbages and cauliflowers may be protected from injury by placing around the stems, at the time they are planted out, a disc made of one-ply tarred felt paper. The implement for making the discs is shown in the accompanying figure at A. Some growers use a square disc. Such a tool as is here illustrated can be made by any expert blacksmith. The blades are made of steel bent in the form of a half hexagon and then taking an acute angle reach nearly to the centre. The part making the star-shaped cut is formed from a separate piece of steel so attached to the handle as to make a close joint with the blade. The dotted lines shown at C indicate how the tool is used. The edge of the tarred felt paper should first be cut by using one edge of the tool. By thus placing the tool where the dotted lines are shown and striking the handle with a hammer, or wooden mallet, a complete hexagonal disc is cut out similar to that shown at B. One yard of tarred felt paper is sufficient to make about 200 discs. In small gardens where only a few discs would be required the grower by following the diagram closely



(A), Tool used for cutting tarred felt paper discs, one-third size; (B) disc about one-half size; (C) showing how the tool is used, the dotted line indicates the position of the edge of the tool. (After Goff.)

could cut with a sharp knife a sufficient number of discs for his purpose. It is important that the discs be placed around the stems of cabbages and cauliflowers immediately the plants are set out. In placing the disc, one side is raised sufficiently to allow the parts of the star at the end of the slit to point upwards and thus fit closely to the stem. The whole disc is then pressed down firmly so that it will rest evenly on the ground.

Cutworms

These well-known smooth, cylindrical caterpillars feed, under normal conditions, at night, hiding in the soil during the day. The surface-feeding cutworms cut off the plants near the ground, or a little below it. A female cutworm moth lays several hundreds of eggs, usually on the leaves of weeds, grasses, shrubs, etc. The moths of the chief injurious species appear in June, July and August. Cutworm injury, as a rule, ceases before the end of June. The more regularly-occurring species are the Red-backed Cut-

worm, *Euxoa ochrogaster* Gn., the Dark-sided Cutworm, *Euxoa messoria* Harris, and the Greasy Cutworm, *Agrotis ypsilon* Rott. Of recent years years the Striped Cutworm, *Euxoa tessellata* Harris, has been an important garden pest. (See fig. 1, page 34).

Cutworms are general feeders, attacking all kinds of vegetable plants; cabbages, cauliflowers, beets, carrots, beans, etc., particularly when young and succulent.

Remedies.—The poisoned bran mixture described on page 40 is the remedy which is now used most extensively. In gardens containing rows of vegetables the mixture should be scattered thinly along the rows on either side, as soon as cutworm injury is noticed. It is important that the poisoned bran be scattered after sundown so that it will be in the very best condition to attract the cutworms when they come out to feed at night.

In small gardens as soon as cutworm injury is noticed the culprits can as a rule be easily located in the soil, about an inch or so beneath the surface, and within a radius of a few inches of the plant, and destroyed by hand.

Flea Beetles

The small dark coloured "flea beetles" so called from their habit of leaping or jumping, eat holes into the leaves of cabbages, turnips, radishes, potatoes, tomatoes and other vegetables. In size they range from about one-twentieth to one-quarter of an inch in length. They are most injurious in spring, at which time serious injury is often effected.

The Turnip Flea Beetle, *Phyllotreta vittata* Fab., is a very common species. It is of a shining black colour and in length about one-sixth of an inch. On each wing cover there is a wavy band of yellow. (See fig. 2, page 33). The Potato Flea-beetle, *Epitrix cucumeris* Harris, is another abundant species which is often found feeding on the leaves of cabbages. It measures from about one- sixteenth of an inch to one-twelfth of an inch in length and in colour is black with pale reddish legs.

Remedies.—Spray the infested plants with an arsenical mixture containing either Paris green or arsenate of lead (page 39) or with the Bordeaux mixture alone (page 39), which acts as a deterrent. Paris green may be used dry with a powder (page 39).

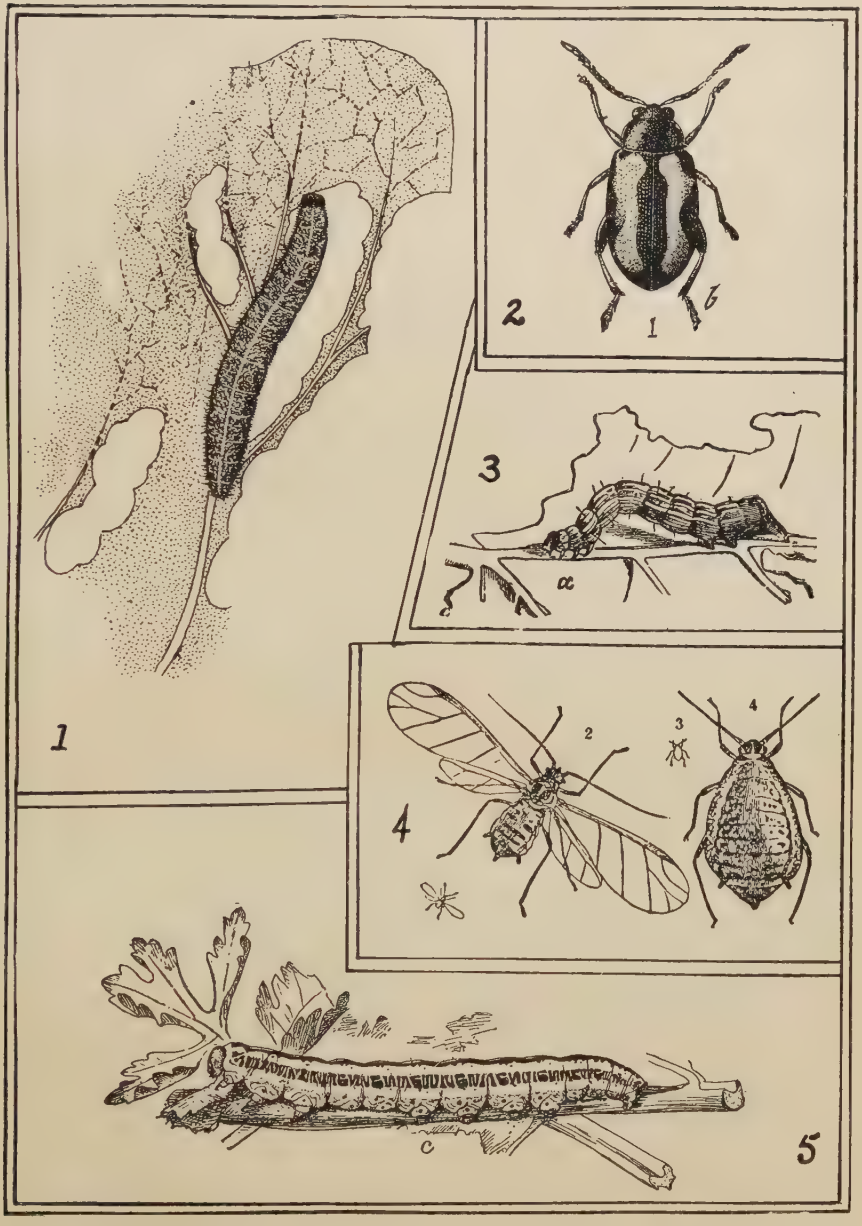


Fig. 1. Cabbage Worm and its work, enlarged one-third (original). 2, Turnip Flea Beetle, enlarged eight times (after Chittenden). 3, Cabbage Plusia, about natural size (after Chittenden). 4, Cabbage Aphis. (2 and 4 enlarged). 5, Zebra Caterpillar (after Chittenden).

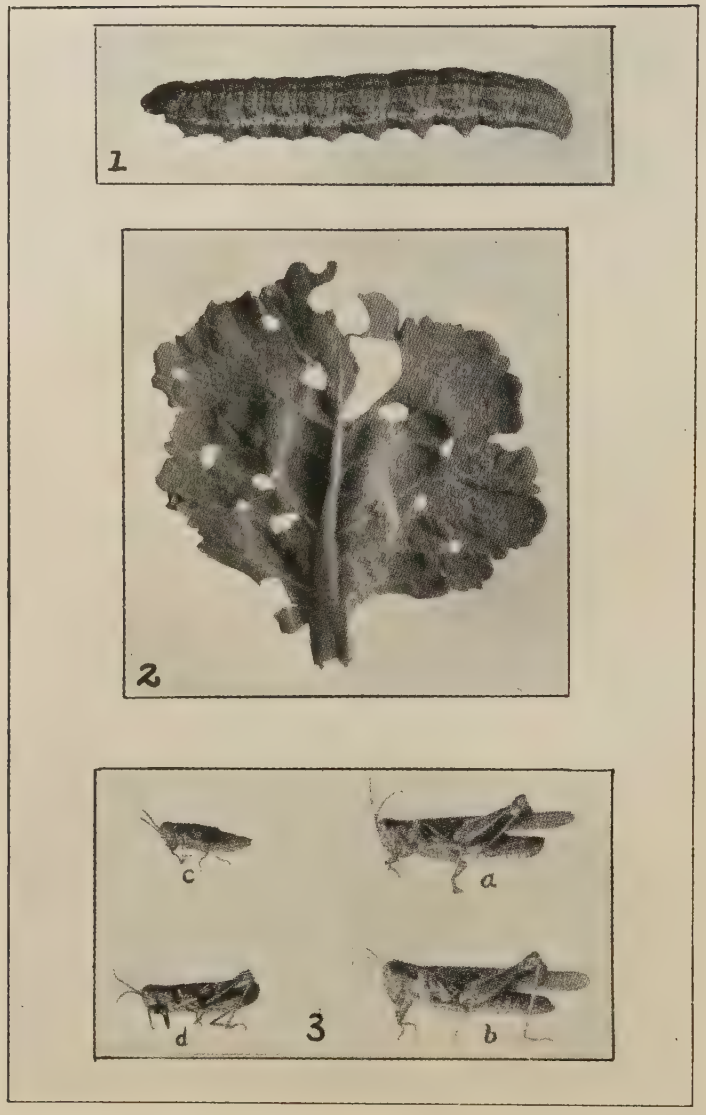


Fig. 1. Striped cutworm, one-quarter enlarged (author's illustration from Bull. 10, Ent. Br., Dom. Dept. Agr.). 2, work of caterpillar of Diamond back moth, cocoon of larva on leaf (original). 3, lesser migratory locust, c and d immature stages, a and b adults, (author's illustration, from Cir. 5, Ent. Br., Dom. Dept. Agr.)

The Cabbage Butterfly, *Pieris rapae* L.

The green caterpillar of the White Cabbage Butterfly, generally called the cabbage worm, destroys large numbers of cabbages every year. (See fig. 1, page 33). The butterflies are very common in gardens where they may be seen depositing their eggs on the leaves of cauliflowers and turnips in addition to cabbages, as well as, frequently, on the foliage of nasturtium and mignonette.

Remedies.—Dusting the infested plants with fresh pyrethrum insect powder and cheap flour, one part of the former in four of the latter, is a useful remedy. The powder and flour after throughly mixing together should be kept in a tight vessel for 24 hours before using. The mixture may be applied from a duster, sold by seedsmen, or from a cheese cloth bag tied on the end of a short stick, the operator holding the bag over the plants and tapping the stick with a cane held in the other hand as he walks along the rows.

Paris green $\frac{1}{4}$ of a pound to 40 gallons of water, or dry arsenate of lead 2 pounds to 40 gallons, may be safely used as a spray for cabbages *until the heads are half formed.* If either is used add the "sticker" mentioned on page 39.

The Diamond-Back Moth, *Plutella maculipennis* Curt.

The small green caterpillars of this moth are in some years decidedly destructive to the leaves of cabbages, turnips, etc. The caterpillars are very active and when disturbed wriggle backwards. When full grown, at which time they are about three-eighths of an inch in length, they spin open network cocoons on the lower sides of the leaves, and then change to the pupal state, (See fig. 2, page 34).

Remedies.—In gardens, spraying the infested plants with kerosene emulsion (page 40) will destroy the caterpillars if applied, as an under spray, to come into contact with them. The remedies mentioned for the Cabbage Butterfly are also useful if the mixtures are forced up among the leaves.

The Zebra Caterpillar, *Ceramica picta* Harr.

This insect occurs, intermittently, in eastern Canada in numbers sufficient to cause considerable anxiety to growers of cabbages and turnips. Fortunately, however, such outbreaks have generally occurred late in the season, consequently the injury has not been so important as would other-

wise have been the case. The caterpillar is about two inches long when full grown, of a velvety black colour with two conspicuous yellow stripes on each side of the body which are connected by narrow lines of the same colour. (See fig. 5, page 33).

Remedies.—Same as those recommended for Cabbage Butterfly. In small gardens their numbers may usually be kept down by hand picking.

The Cabbage Aphis, *Aphis brassicæ* L.

There are few kinds of plants which are free from injury by the various species of plant lice which are also known as "Aphis" and "Green Fly." Cabbage, turnip, potato and other vegetable crops are almost every year injured seriously. The Cabbage Aphis is the chief destructive species of the cabbage. (See Fig. 4, page 33). It is of a grayish colour and occurs in conspicuous clusters around the bases of the stems and on the undersides of the leaves. All plant lice are sucking insects and live solely on the juice which they extract from their host plants.

Remedies.—The Cabbage Aphis, as a rule is not noticed in destructive numbers until late in the season. Much can be done to prevent the spread of this insect, if the earlier colonies are destroyed. Any of the contact insecticides mentioned for sucking insects, on pages 40-41, will destroy this insect. It is important that whichever insecticide is used should be applied so as to reach the places where the insects are clustered. Only the plant lice which are actually hit by the spray will be killed. As the Cabbage Aphis passes the winter in the egg state, the eggs being deposited on the leaves, it is important that all remnants of crops be destroyed by ploughing down as soon as possible after the heads are harvested.

The Onion Thrips, *Thrips tabaci* Lind.

The Onion Thrips is a very small insect about one-twenty-fifth of an inch long and of a pale yellowish colour. In addition to the onion, the insect feeds on the leaves of cabbage, cucumber, tomato, etc.

Remedies.—Any of the contact insecticides mentioned on pages 40 and 41 are useful in controlling this insect. Tobacco preparations are preferred by many growers.

The Cabbage Plusia, *Autographa brassicæ* Riley.

Occasionally in eastern Canada the caterpillars of the Cabbage Plusia, are abundant enough to attract attention. When full grown the cater-

pillar is about one and one-quarter inches long, pale green in colour, with whitish stripes. It loops its body when walking. (See Fig. 3, page 33).

Remedies.—Spray with Paris green or arsenate of lead as recommended for the Cabbage Butterfly.

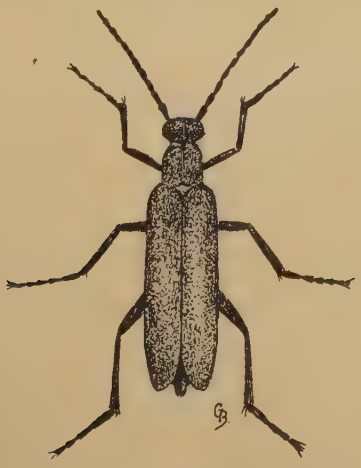
The Purple-backed Cabbage Worm, *Evergestis straminalis* Hbn.

In the Maritime Provinces this insect has been responsible for important injury to the foliage of cabbages and turnips. In Quebec province the caterpillar has, also, been observed in small numbers during certain seasons. It is of a purplish colour, about three-quarters of an inch long when full-grown; the body bears conspicuous bristles and on either side is a yellow stripe.

Remedies.—Dust the plants with insect powder and flour, or spray with an arsenite as recommended for the Cabbage Butterfly.

Blister Beetles

There are a few kinds of blister beetles which almost every year cause considerable anxiety to farmers and gardeners from their habit of appearing suddenly, in large numbers, and feeding on potatoes, beans, beets, cabbages, carrots, corn, tomatoes and other vegetables, and ornamental plants, such as aster, clematis, zinnia, chrysanthemum, etc. In eastern Canada the Black Blister Beetle, *Epicauta pennsylvanica* DeG., the Ash-gray Blister



The Ash-gray Blister Beetle, *Macrobasis unicolor* Kirby. (Original).

Beetle, *Macrobasis unicolor* Kirby, and the Gray Blister Beetle *Epicauta cinerea* Forst, are the better-known species. All are soft-bodied insects; in shape they are slender and cylindrical, and about one-half an inch in length.

Remedies.—Paris green or arsenate of lead (page 39) will control blister beetles, but it is often necessary to repeat the application as the beetles which are killed are soon replaced by others. It would not be advisable to use either of these arsenicals too freely on cabbages. If after the heads are half formed, such plants are found to be infested by blister beetles, and one application is not sufficient, it would be advisable to resort to the old "driving" remedy which has often been successfully employed. Two or three boys, or more if necessary, walking through an infested plot or field and waving from side to side boughs of spruce, or other branches, should disturb the beetles and drive them ahead. When the insects come to the edge of the crop they will disperse and seldom return.

Locusts

In years of abundance these insects, particularly the Lesser Migratory Locust, *Melanoplus atlanis* Riley, the Red-legged Locust, *Melanoplus femur-rubrum* DeG., the Pellucid Locust, *Camnula pellucida* Scudd. and the Two-striped Locust, *Melanoplus bivittatus* Say, very often migrate to vegetable gardens and cause serious damage by devouring the foliage of potato, cabbage, corn, celery, etc. (See Fig. 3, page 34).

Remedy.—The poisoned bran mixture (page 40), with the addition of the juice and peel of 3 oranges or 3 lemons, is a valuable means of destroying large numbers of these insects. The bait should be broadcasted lightly early in the morning to attract the locusts when they are hungry after their night's rest. Four pounds of the mixture is sufficient to treat one acre.

Snails and Slugs

Very often these soft-bodied molluscs are decidedly destructive in vegetable and flower gardens, attacking many different kinds of plants. They are nocturnal in habit, hiding during the day beneath stones, clods of earth, etc.

Remedies.—As they come out to feed in the evening, an excellent remedy is to broadcast lightly over the soil, before nightfall, freshly slaked lime. This adheres to their bodies and soon kills them. Three applications on consecutive evenings are advisable. Shingles placed here and there throughout an infested garden and under low growing plants will attract many slugs, forming as they do suitable shelters for these creatures. If the shingles are turned over in the morning the slugs there hiding may be easily destroyed by scraping them off and crushing them with the foot.

INSECTICIDES

For Biting Insects

PARIS GREEN:

Liquid application.—Use in the strength of 4 ounces to 40 gallons of water, with about half a pound of fresh lime added. Where only a few plants are being treated one teaspoonful, with the same quantity of lime, to a pail of water is sufficient.

Dry application.—1 pound of Paris green mixed with 20 pounds of land plaster, slaked lime or other perfectly dry powder. Should be used early in the morning when the plants are wet with dew.

Sticker.—When spraying cabbages, the leaves of which are covered with a waxy secretion, with a Paris green mixture the same will adhere better if a "sticker" is added. Such can be made by boiling together for about an hour, 2 pounds of resin and 1 pound of sal soda (crystals) in a gallon of water. This is sufficient for 40 gallons.

ARSENATE OF LEAD:

Preferred by many growers owing to the fact that it does not burn the leaves and remains much longer on the foliage than Paris green, not being washed off to the same extent by rains. The powdered arsenate of lead is used in the strength of 2 pounds to 40 gallons of water, the paste form in the strength of 4 pounds to 40 gallons. For use in small quantities one tablespoonful of the paste arsenate of lead is sufficient for one gallon of water.

POISONED BORDEAUX MIXTURE:

Bordeaux mixture is made as follows:

Copper sulphate (bluestone)	4 lbs.
Unslaked lime	4 lbs.
Water (1 barrel)	40 gallons.

Dissolve the copper sulphate (by suspending it in a wooden or earthen vessel containing 4 or 5 or more gallons of water). It will dissolve more quickly in warm water than in cold. Slake the lime in another vessel. If the lime, when slaked, is lumpy or granular, it should be strained through coarse sacking or a fine sieve. Pour the copper sulphate solution into a barrel, or it may be dissolved in this in the first place; half fill the barrel with water;

dilute the slaked lime to half a barrel of water, and pour into the diluted copper sulphate solution, then stir thoroughly. It is then ready for use. (Never mix concentrated milk of lime and copper solution.)

A stock solution of copper sulphate and milk of lime may be prepared and kept in separate covered barrels throughout the spraying season. The quantities of copper sulphate, lime and water should be carefully noted. Bordeaux mixture deteriorates with age and should be used as soon as made.

To test Bordeaux mixture, let a drop of ferrocyanide of potassium solution fall into the mixture when ready. If the mixture turns reddish-brown, add more milk of lime until no change takes place.

Poisoned Bran Mixture. (For Cutworms and Locusts.)

Bran	20 lbs.	Paris Green	½ lb.
Molasses	1 quart	Water	2 to 3 gallons

Mix the bran and Paris green thoroughly in a wash tub, while dry. Dissolve the molasses in the water and wet the bran and poison with the same, stirring well so as to dampen the bran thoroughly.

For cutworms a simple formula for small gardens is one quart of bran, one teaspoonful of Paris green and one tablespoonful of molasses, with sufficient water to moisten the bran.

Shorts or middlings in place of bran are also useful for cutworm control. For locusts excellent results have been obtained with sawdust used as the carrier for the poison.

For Sucking Insects

Kerosene Emulsion:

Kerosene (coal oil)	2 gallons.
Rain water	1 gallon
Soap	½ pound.

Heat the water, cut the soap into fine shavings and add them to the water, stirring till all is dissolved, then pour this into the kerosene and churn the whole violently with a syringe or force pump for about five minutes or until a thick creamy emulsion is produced. This makes the stock solution which as it cools thickens into a jelly-like mass. When required for use dilute with nine times its measure of warm water. The stock solution when properly made will keep for months if kept from the air.

WHALE OIL OR FISH OIL SOAP:

Has been used extensively for aphids, etc. For green aphids, like the Cabbage Aphis, it should be used in the strength of one pound to 6 gallons of warm water; for brown aphids or thrips, in the strength of one pound to 4 gallons of water.

TOBACCO EXTRACTS:

Trade preparations of nicotine are sold by nearly all seedsmen. Two of these which are widely used for sucking insects are "Nickoteen" and "Black Leaf 40." It is desirable to add soap to the diluted spray at the rate of about two pounds to 40 gallons of mixture.

WHAT INSECTICIDES AND FUNGICIDES SHALL WE USE IN 1917, AND WHEN SHALL WILL SPRAY THIS YEAR?

Father Leopold, Oka Agricultural Institute.

Spraying operations, to my mind, are among the most important operations in the orchard, and it seems to me that the further we go the more we have to learn about the whole gamut of these operations. Some years ago we left out Bordeaux mixture, more or less, to take up Lime Sulphur Wash; we found that Paris Green was not so good as Arsenate of Lead. Then we used paste Arsenate of Lead and we are beginning to replace it by the powder, and now, I am asking myself if we cannot find a cheaper and just as effective an insecticide as arsenate of lead. I am also convinced that we can omit without loss the dormant spray and yet get a good crop of Fameuse and McIntosh apples without apple scab.

I am offering here for your consideration and discussion a few important items in spraying that may mean a saving this year either in the crop itself or in the buying of the necessary quantity of insecticide for the fruit grower.

The first point I wish to mention is that according to the results and experiences in Nova Scotia of Mr. G. E. Sanders, the Field Officer in charge of the Dominion Entomological Laboratory at Annapolis Royal, perhaps we should substitute arsenate of lime for arsenate of lead in all lime and sulphur sprays and with Bordeaux mixture.

In regard to substituting arsenate of lime for arsenate of lead, I may state that arsenic, in the form of arsenate of lime, will cost less than 55% of what arsenic will cost in the form of arsenate of lead.

Arsenate of lime does less damage than arsenate of lead with an equal strength of lime sulphur. When we add arsenate of lead to lime sulphur solution a chemical change takes place resulting in the formation of lead sulphide and three kinds of arsenate of lime, one of them, mono-calcic-arsenate, is entirely soluble and is the cause of a large part of the burning which comes from the use of lead arsenate and lime sulphur together. When arsenate of lime is added to lime sulphur no chemical change takes place and so no soluble arsenic is formed. Therefore arsenate of lime is safer than arsenate of lead with lime sulphur wash.

Moreover, arsenate of lime causes less waste when it is added to lime sulphur solution than does arsenate of lead. When arsenate of lime is added no chemical change takes place, but when arsenate of lead is added nearly all the lead goes to the bottom of the tank as lead sulphide precipitate or sludge. Thus 35% of the sulphur is lost from the solution and it is on

the sulphur principally that the solution depends for its fungicidal value. Lead arsenate thus takes away one third of its value. Also on account of the fact that the agitation of the sludge is more difficult, more arsenate of lead is lost, which should go on to the trees, but stays in the bottom of the tank.

Arsenate of lime is cheaper in its more convenient form, the powder, than arsenate of lead, though the makers are, in my opinion, asking a pretty high price for the arsenate of lime, which should be much cheaper than it is. Comparing both prices, I have had what one would call fair quotations of both: arsenate of lead at 23 cents a pound and arsenate of lime at 18 cents a pound, if bought by the carload lot.

Arsenate of lead, when used alone, is a safe insecticide. We must admit that this is not the case with arsenate of lime. It should *never be used alone.* When used in combination with sulphur washes it is safer than arsenate of lead especially for the sprayings following the calyx spray, when the small apples are formed. Arsenate of lead *when used alone* is by far the *safest* insecticide.

The second point which I wish to discuss with you is this: Is there any advantage in using Bordeaux mixture to prevent the falling off of apples which some claim is due to lime sulphur injury?

The conditions may not apply to our province, but let me state that in Nova Scotia there has been this season some complaint that the apples were dropping too much in orchards sprayed with the lime sulphur solution, while in the others sprayed with Bordeaux mixture there was considerably less dropping.

To investigate the matter fully Mr. Sanders tried out both Bordeaux mixture and lime sulphur to find out at what period the lime and sulphur did the most burning and caused the most dropping of the apples, and also to find out if there was a period at which Bordeaux mixture did less damage than the lime and sulphur. The following are the results:

	L.S. 1.009 s.g. lead arsenate 1 lb. to 40 gallons.	B.M. 4-4-40 Dry acid lead arsenate 1 lb. to 40 gallons.
Immediately before the blossoms, 1 spray only	159	327
Immediately after the blossoms, 1 spray only	108	204
Two weeks after the blossoms, 1 spray only	30	231

Unsprayed trees averaged 277 apples per pair.

Percentage of russeting when Bordeaux was used.

Immediately before the blossoms..... 7 per cent russeted.
Immediately after the blossoms.....43.6 per cent russeted.
Two weeks after the blossoms..... 3 per cent russeted.

These figures show that the greatest damage comes from the use of strong lime sulphur two weeks or more after the blossoms and it also shows that Bordeaux used two weeks after the blossoms is harmless in so far as removing the set of fruit is concerned.

It has been always an open question as to what causes the russeting of the fruit when we use Bordeaux, and it appears from what Mr. U. P. Hedrick (Bulletin No. 28, New York Exp. Station) says that "From the study of the matter at this station it does not seem possible that Bordeaux injury occurs on apples after the hairs have been shed, the stomata changed to lenticels and the waxy coating formed." Mr. Sanders claims that Bordeaux will cause less injury than any other equally efficient spray when used two weeks after the blossoms fall. It is not recommended to use it for the two first sprays at least.

In the face of this evidence, I am asking why some of our fruit growers, at least those owning our Demonstration orchards in this Province, should not try our new schedule of spraying, it being in itself as economical as possible.

Spraying Recommendations:

No dormant spray against scab.

1st spray for scab and insects: When each individual bud is showing pink and petals are separated: Lime Sulphur, 1.007 s.d. and 2 lbs. of arsenate of lime to 100 gallons of water.

2nd spray.—Immediately after blossoms fall: Lime Sulphur, 1.006 s.d. and add 1½ lbs. of arsenate of lime to 100 gallons of water.

3rd spray.—First choice: Bordeaux, 7-7-100, with arsenate of lead or arsenate of lime as a poison, or, Second choice: Two to three weeks later, apply Lime Sulphur, 1.005 s.d. and add 1 lb. only of arsenate of lime to 100 gallons of water.

N.B.—In wet seasons it may be necessary to spray twice before the blossoms and then I would advise the same spray as for the first one marked above. All sprays made after the last one recommended here should be alike.

PHYSIOLOGICAL DISEASES OF POTATOES

Dr. M. F. Barrus, Cornell University

Potatoes are so high priced this spring that a discussion of any phase of culture looking toward greater production has an interest not only to scientific men and to farmers but to the general public as well. A large amount of investigational work on potatoes with special reference to disease is being conducted by various agricultural institutions and as a result new ideas are being formulated and new aspects of the problem continually opened up. The scope of investigations is indeed so large that the writer is content to present only a small part, and that as the result of observation and study rather than active participation in research of this kind.

The high prices that potatoes have commanded this winter have induced many farmers to sell until they are short of seed or have reduced the quality of that which they have reserved. The principal reduction in quality has been in size of seed, for the larger tubers being more marketable will have been sorted out and sold. It is doubtless unnecessary to point out to you, as should be done generally to farmers, that diseases transmitted by the tuber are often responsible for a large number of the small tubers. When one uses for planting tubers large and small as they run, the danger of increasing the percentage of these diseases is not great, but when marketable ones are sorted out and the remainder is used for seed the chances of securing a large proportion of tubers that came from diseased plants is very great. Such affected tubers are sure to give a disappointing yield. The matter would not be so serious were it possible to detect readily these tubers from healthy ones, but the very nature of the diseases, as will be seen, makes this impossible except in a few cases.

Of the more serious diseases affecting the plant so as greatly to reduce the yield are the so-called "physiological troubles" or constitutional diseases, leaf roll, curly dwarf, and mosaic. No attempt will be made to describe them in detail in this paper, but their names serve to do this to some extent. In each case the foliage lacks the deep green colour and normal spread of leaves that healthy plants have. The cause of these diseases is to a large extent a matter of speculation among scientists. They seem to be much related especially in certain cases and may be varied manifestations of the same disorder. That affected plants give reduced yields is evident from the average smaller size of the tubers they produce. Such tubers show no indication of disease and are apparently in no way different from healthy

ones of the same size. The resulting plants certainly are different for they show in a more advanced stage the disease which affected the parent plant. But it is not always possible to differentiate the one from the other. Mosaic in advanced stages may have the appearance of curly dwarf. Leaf-roll however, usually has rather distinct symptoms. The reduction in yield in such advanced stages is very marked. The few tubers usually produced are often no larger than hickory nuts. It is not definitely known whether these diseases are contagious, and, if they were not there would be no further danger from such badly affected plants as the tubers are too small to be used for seed purposes. Quanjer[1] believes that leaf roll is contagious to a certain extent and that the soil in which affected plants are grown can become contaminated by the virus so that healthy tubers planted there may produce diseased plants as a result of this soil contamination.

Evidently elimination is the only method of control. Even that cannot be entirely depended upon, for apparently healthy, high-yielding strains have sometimes produced affected individuals in later plantings. Professor F. C. Stewart[2] has given a number of instances of this kind and the writer observed a similar case in northern Vermont in 1916. An intelligent grower, having secured after several years selection from high-yielding strains a quantity of potatoes which he intended to place on the seed market, found to his disappointment that a large proportion of them (over 30%) showed curly dwarf. He said that he had found a small percentage of such plants the preceding year but had rogued them out. It is probable that the plants originally selected contained the elements of this disease or were latently affected and, although the progeny produced well for several years, the break was certain to come. Such an experience, however, tends to discourage further efforts toward seed improvement. Quanjer[3] also states that selection cannot be depended upon to reduce the extent of leaf roll.

In New York State, leaf roll and curly dwarf seem not to be very prevalent. Mosaic, on the other hand, is very commonly met with on white sprout potatoes, but the writer has never observed it on the blue sprout varieties. Plants may become very much dwarfed by it and not uncommonly the vines of rather large plants become more or less prostrate. Other plants may show the mottling plainly but otherwise are as large and produce as well as neighboring healthy vines. Then there are plants so

[1] Quanjer, Dr. H. M., Lek, H.A.A. van der, and Botjes, J. Oortwijn, Nature, mode of dissemination and control of phloem-necrosis (leaf-roll) and related diseases i.a. Sereh. Reprint from "Mededeelingen von de Rijks Hoogere Land-Tuin-an Boschboun school" 10:84-138, English translation, pls. 1–12, 1916.

[2] Stewart, F. C. Observations on some degenerate strains of potatoes. New York (Geneva) Agr. Exp. Sta. Bul. 422:319–357, pls. 1–12, 1916.

[3] L.c. p. 109–111.

(*Photo R. J. Haskell*)

Early Ohio potato plant showing early effects of streak.

Leaf of evergreen potato (pressed specimen) showing regular spotting of leaf by streak.

Two Evergreen potato plants, the one on the left coming from a tuber selected the year before from a healthy plant, the one on the right coming from an average sized tuber selected the year before from a plant affected by streak.

slightly affected that it is difficult to tell with certainty whether mosaic is really present. Some of our highest yielding fields have had considerable mosaic. The problem of handling this disease is a very real one in New York where we are endeavouring to certify high-grade healthy seed and yet not exclude high-yielding stock.

Streak is another disease that produces a condition somewhat similar to those already mentioned in that the plant becomes much dwarfed and weakened. The writer's first experience with this disease, as he diagnosed it, was with tubers sent us from Idaho by Dr. H. A. Edson of the United States Department of Agriculture. These tubers came from plants having leaf roll and were sent that we might observe leaf-roll characters. About a month after the plants had appeared, one plant at the end of the row which had been much dwarfed from the time it appeared showed a spotting of the foliage similar to early blight. This was first thought to be the trouble, but a closer examination showed dark streaks in the petioles and the stalks. The petioles were so brittle that they broke in two readily when the leaves were touched and the stalks were easily broken also. Later the leaves died, beginning with the lower ones, so that after a time there were but a few small green leaves at the apex. The entire plant died much earlier than normal ones and the few tubers produced were the size of marbles.

Not long after the discovery of the first a second and then a third plant from the Idaho seed were found affected in this same manner. For a time this was thought to be a character peculiar to leaf roll but this opinion changed when the spotting of the leaves was found on vigorous Evergreen potato plants growing in a row adjoining those mentioned. These Evergreen potatoes had been grown in the diseased garden for the two preceding years in order to test their reputed resistance to late blight, but the spotting described had never been observed on them. It seemed evident then that the disease is infectious. This surmise was strengthened by the spread of the disease to several other Evergreen potato plants. However, an attempt to obtain an artificial infection by the inoculation of healthy plants with bacteria obtained from a culture made from an affected stem was without success.

The Evergreen plants affected, while they showed the same leaf spots as the Idaho plants and showed a similar streaking of petioles and stems followed by early death of affected parts, did not have the dwarfed appearance as the vines were large before the infection showed. Some were affected at first on but a single stalk but the other stalks became affected later, and in all cases the decline of the vine after infection was rather rapid.

The tubers from affected Evergreen plants showed no evidence of any disease on any part. The yield from such affected vines was not as large as from healthy ones as the tubers had not completed their growth at the time the vines died.

Tubers from affected and from healthy Evergreen vines were placed in separate sacks and saved. These were planted the following year (1916) and the behavior of the resulting plants observed. The tubers from healthy plants again produced vigorous growing vines which did not become affected with this disease at any time during the year. Tubers from affected vines produced plants that resembled in most respects the plants from Idaho tubers on which the disease was first observed. They were much dwarfed, the petioles and stalks were streaked with brown and were brittle, and the entire plant died early, producing only very small tubers. No healthy plants were observed to contract the disease that year.

Mr. R. J. Haskell of our department planted a portion of this Idaho seed in 1915 at Hopewell Junction, Dutchess County, N.Y., where he was working on potato diseases at a field station. This same streak disease appeared on several plants from this seed and they behaved otherwise in much the same manner as has been described.

This disease has been described in some detail here because of its interesting character and because little has been written about it. It is evidently infectious and of a bacterial nature. Careful work should result in the isolation of the causal organism. Apparently this micro-organism can be carried over winter on the seed, and if this be the only way, disinfection should be an effective remedy. However, unless the disease appears more prevalent than in the past, it is not one requiring preventive measures.

Returning again to a discussion of the cause of small tubers, it should be pointed out that plants affected with Fusarium and Verticillium wilt, black leg, rhizoctoniose, leaf blights and other diseases, as well as plants lacking vigor, produce small tubers. Since many of these troubles are transmitted with the tuber, it can plainly be seen that the continued use of small seed is bound to result in the introduction of diseases of this kind with consequent low production and final running out. The elimination of tubers of such plants from the seed is the practical means of avoiding this condition.

It should be stated here that tubers which are small because of immaturity are not necessarily unfit for seed. Instead, the use of immature seed tubers has been advocated and is practiced by some very successful potato

growers. An early frost last autumn in New York State is partly responsible for many small potatoes in last year's crop.

If the writer has any message to give to Quebec farmers it is to encourage them to produce high-grade seed potatoes. The demand for such potatoes will never lessen. There is no better location for the production of seed tubers than in these northern sections. If one will but practice seed selection, maintaining a seed plot each year, will treat his seed tubers with corrosive sublimate, and spray his vines with bordeaux mixture, there can be no reason why he should not produce disease-free seed, but most important of all these measures is the selection of seed from healthy, high-yielding plants.

HISTORICAL NOTES ON ENTOMOLOGY IN THE PROVINCE OF QUEBEC

Canon V. A. Huard, D.Sc., Curator, Museum of Public Instruction, Quebec.

Although our Province of Quebec is considered in certain quarters to be behindhand, it has nevertheless led the way in Canada in many pursuits of an intellectual and artistic nature. It still stands at the head in the realm of art, literature, science, philosophy and theology, and it is of this pioneer work in one particular branch of science, entomology, that I wish to speak.

Neither in the Province of Quebec nor elsewhere in Canada can we trace the history of entomology back into the "dark ages." There is no trace of any entomologist among the great thinkers who made illustrious the ages of Pericles, Augustus and Louis XIV; neither Jacques Cartier nor Champlain numbered an entomologist among his followers, the reason being that entomology at that time had not come to be recognized under the title of a special study. Our worthy ancestors may have taken up the raising of silkworms, bees and cochineal for industrial purposes, but for the rest they limited themselves to measures of defence against such personal enemies as flies, mosquitoes, etc., and it was not until the eighteenth century that Linnæus took up the scientific study of the insect world.

In America entomology has only reached the age of half a century; it is not even so old as this if one speaks of its "official" existence so far as it has been publicly known and encouraged. For a long time it only existed as a special study which was taken up privately by a few people.

In the Province of Quebec, with which I wish to deal more particularly, the first name to be recalled in the history of entomology is that of William Cooper, who lived in several of our larger towns towards the middle of last century. He appears to have been the first man in Quebec to make a collection of insects, and his name is connected with the discovery of several new species of Lepidoptera and Coleoptera. He was probably the first to make a study of the insects of Labrador and the Island of Anticosti. He contributed articles to the *Canadian Entomologist* and to the *Canadian Naturalist* of Montreal.

It was the latter paper that also published the works of two other pioneers of entomology in this country: D'Urban and Barnston. William Stewart D'Urban appears to have been an Englishman who spent several years in Montreal prior to 1861. Among the articles he wrote may be mentioned the following: "Descriptions of Four Species of Canadian Butterflies," 1857; "Description of a Canadian Butterfly and some Remarks on Genus Papilio," 1858; "A Systematic List of Coleoptera found in the Vicinity of Montreal," 1859.

George Barnston, an employee of the Hudson's Bay Company, lived in Montreal for several years. We find that in 1860 he published in the Montreal Magazine "A Catalogue of Coleoptera collected in the Hudson's Bay Territories," this being, without doubt, the first time that the Hudson's Bay country had figured in entomology, and I doubt if it has ever done so since.

Prior to 1858 entomology in Canada had been mainly supported by the English-speaking people, but during that year a Frenchman named Provancher came to the front rank among Quebec entomologists, which position he maintained for a great many years. He published in that year his first work on Canadian insects. This book, dealing with insects attacking grain, laid the foundation of "economic" entomology, and it was before this branch of insect-study had even received its name. It was, at all events, the first public manifestation in Quebec, if not in Canada, of this branch of entomology, which today occupies such an important position in the world.

It was not only in economic entomology, however, that Provancher did such valuable pioneer work. It was he who published the first treatise on botany, the first work on orchards and gardens, the first flora, and the first technical study of insects. Today, several of these works are regarded as classics and have not yet been replaced by more modern and up-to-date books. It was he also who founded the first French review of natural history published in America, *Le Naturaliste Canadien*. The first number of this review appeared in the month of December, 1868, and it is a coincidence that in the same year the *Canadian Entomologist* was brought out—the only scientific magazine in the Province of Ontario. Although its name did not suggest entomology to any great extent, the *Naturaliste* always gave a good deal of attention to this subject, and shortly after its foundation Abbé Provancher began to devote himself more exclusively to the study of insects. He added later the study of molluscs, but it may be truly stated that though he commenced his career as a naturalist with botany, he ended it with entomology, to which he devoted the last twenty-two years of his life.

One might say that, but for Provancher, Canada, and particularly the Province of Quebec, would not count for much in the history of entomology. But let us consider the merits of our Canadian Linnaeus. He had the courage and hardihood to undertake the publication in those early days, in a country still young, of his "Flore Canadienne" (1862), and he gave a still greater proof of these sterling qualities when he undertook, in 1877, to publish in our country such an extensive work as his "Petite Faune Entomologique." One can better realize the value of this work when it is remembered how very few countries possess any complete work on their entomological fauna; and usually where there is such a work it is the results of the combined efforts of a number of authors. But nowhere, since Linnaeus, had there been found an author to attempt a complete work on the entomology of a country—nowhere, except in the province of Quebec, where Provancher not only undertook the work but accomplished a large part of it. It must be acknowledged, in excuse for the lack of attempt to bring out a complete work on the natural history of insects, that entomology is as yet only in its infancy. Very little can be regarded as definitely achieved as yet, and entomologists will require to make many changes in their collections of insects, for the various families and species are so numerous that they have only been imperfectly studied so far, and every day new discoveries are made which tend to upset the classifications already established. Provancher, for his part, discovered and named no less than three of four hundred species of insects of the Province of Quebec, and the greater part of these have been upheld by entomological authorities, thus securing scientific immortality to our illustrious fellow-countryman.

His chief claim to the title of pioneer and even *father* of Canadian entomology, lies in the technical works which he published on the history of our insects. To be sure, their practical value has somewhat decreased since discoveries are many and progress is rapid in the science of entomology; but these works, in their broad outline at least, are still necessary for the beginner in the study of our insects, and will for a long time to come guide amateurs in the vast realm of entomology.

The following is a brief history of this great work—the "Petite Faune Entomologique du Canada"—of which the first volume, devoted to Coleoptera, bears the date 1877. Abbé Provancher published part of this history of our Coleoptera in the *Naturaliste Canadien*. He had brought out in this way about a third of it between the years 1870 and 1873, but he came to the conclusion that it would take far too long to publish the whole work in this manner, and in January, 1874, he presented to the public his first volume complete, dealing with Coleoptera. This volume was of 12mo. size, contained 786 pages printed on de luxe paper, and was sold at $3.00. It is

surprising that a book of this character, so technical and, for the period, costly, should have found a sale. The remainder of the "Petite Faune Entomologique" was published in the form of supplements to the *Naturaliste.* This method was slow, but it seemed to be the only possible way, for it reduced the cost of publication to a minimum. The three volumes would doubtless never have figured among our scientific literature today had it not been possible to bring them out in this way.

Volume II, which comprised Orthoptera, Neuroptera, and Hymenoptera, was published in 1883, and was of octavo size, 832 pages. In 1889 there appeared "Additions and Corrections to Volume II," which contained 476 pages, octavo.

Volume III, dealing with Hemiptera, is dated 1886 and contains 354 pages, octavo.

Abbé Provancher died in 1892, leaving his great work incomplete inasmuch as he was unable to finish the volumes on Diptera and Lepidoptera.

With Provancher ended, for a time at least, the period of entomological bibliography of the Province of Quebec, which had been filled entirely by his own effort. Since the death of our Canadian Linnaeus entomological literature in the province has not been greatly increased by any work of notable value or scientific merit. As a work of pure science one might mention the "List of Coleoptera of Canada" by Joseph I. Beaulne, published in the *Naturaliste Canadien* these years, and the "Lists of Insects of the Province of Quebec" published by the Society for the Protection of Plants as supplements to their annual reports. The List of Lepidoptera, prepared by A. F. Winn, appeared in 1912, and the List of Diptera by A. F. Winn and G. Beaulieu in 1915. These two lists are important and useful in that they help to complete, provisionally at least, the great work of entomology begun by Provancher. Both in applied and economic entomology Provancher was the pioneer, for he also treated of insects in his "Verger Canadien," the third edition of which was published in 1874.

Our Society for the Protection of Plants has published in its annual reports a number of illustrated articles on insect enemies of forests and crops. These articles, written by specialists on the subject, are of great value to everyone interested in the great work of agriculture.

I published myself last year a study of our chief injurious insects.

The most elaborate work on applied entomology which has appeared in the province comes from the pen of Professor W. Lochhead, entitled "A Synopsis of Economic Entomology" which was published in 1914. This

work, over 100 pages in length, is a systematic treatise, although abridged, on our injurious insects. If it were developed our scientific literature would be enriched by the addition of a complete and valuable work on injurious insects. I most sincerely hope that Professor Lochhead will undertake a work of this nature.

An event of great importance in the history of entomology in the province of Quebec took place in January, 1913, when the Provincial Minister of Agriculture decided to appoint an entomologist. I had the honor of being selected for this position, which I occupied until 1916. This was the first official recognition accorded to entomology in our province. Mr. George Maheux, who has made a special study of entomology, now holds this position.

Another notable event was the appointment of the first professor of entomology among the French-Canadian people. This was inaugurated at the Oka Agricultural Institute, where Mr. F. Letourneau was appointed a year or two ago. Mr. Letourneau took a course in entomology at Guelph, and is well known through his articles on insects published in the *Naturaliste Canadien* and by a bulletin published in 1916 on insects injurious to apple trees.

Mention should be made in this memoir, I think, of the chief insect collections which add to the entomological richness of the Province of Quebec. In 1887 the *Naturaliste Canadien* took a census of the museums, etc., in the Province of Quebec. In the report published they enumerated thirteen collections of insects in possession of various institutions and private individuals. The number of such collections at the present time must be much greater. The Universities of Laval and McGill have today the most valuable collections of any in the province. Next come College St. Laurent, near Montreal, which secured some years ago Mr. G. Beaulieu's collection of Coleoptera; Levis College and Sherbrooke Seminary, where Abbés Elias Roy and P. A. Bégin respectively were employed; St. Hyacinthe Seminary, which owns the collection assembled by Abbé F. X. Burque; the St. Lawrence Convent, near Montreal; Mr. C. E. Dionne, the famous ornithologist of Quebec; G. Chagnon, Montreal; and St. Alexander College, Ironside. This list is incomplete and without my knowledge there may be several other insect collections in the Province of Quebec.

But, one may ask, what became of the entomological collections made by Abbé Provancher during his long life? At a date which I do not exactly know Provancher handed his collection to Levis College, and this was the foundation of the important collection in the possession of this institution today. In 1877, before this sale to Levis College, Abbé Provancher had

sold one collection of insects to the Provincial Minister of Agriculture, and this was placed in the Museum of Public Instruction at its foundation in 1880. In 1893 the Department of Public Instruction bought the latest collection he had made prior to his death in 1892. This collection is preserved just as it was classified and named by him, for it will become more and more necessary to refer to it in studying his entomological works. I may add that the three collections at Quebec and Levis contain specimens of nearly all the hundreds of new species he describes.

There is also in the Museum of Public Instruction the collection of insects which belonged to the founder of the museum, Mr. D. N. St. Cyr; this is not very large. We also have the valuable collection of Lepidoptera obtained in 1909 from Rev. Dr. T. W. Fyles. This collection of butterflies, on which Dr. Fyles worked for forty-five years, includes nearly every kind found in the district of Quebec. It contains 2300 specimens, all mounted and named, a number of them being quite rare. They are preserved under the name of the "Fyles Collection."

This brief history will show that up to the present time a certain amount of attention has been given to entomology in the province of Quebec, and I think I am safe in saying that no other province of Canada can show a record in any way comparable with ours. Now that natural history has become part of the curriculum in all our schools it is to be hoped that the time will soon come when the number of our naturalists, and especially our entomologists, will be greatly increased.

THE WHITE PINE WEEVIL, PISSODES STROBI, IN QUEBEC

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The work of this insect is probably the chief cause of distorted and crooked white pine in Eastern Canada. The attack is upon young trees, between five and twenty-five feet in height, and chiefly to those growing in a pure or nearly pure stand or in the open. The work of the grubs kills the terminal shoot on the last one, two, or even three year's growth. The death of the terminal results in a special development of the uppermost living whorl of lateral shoots; the most vigorous of these, one, two, or more in number, assume an upright position and continue the upward development of the tree, resulting in a crooked trunk, a double-top, or a multiple top. Frequently these new terminals are attacked in turn and the value of the tree for timber, or its beauty for ornamental purposes, entirely destroyed.

The work of the weevil has been particularly abundant in Quebec and Ontario for the last five or six years, and in many localities a large percentage of the young growth has been seriously injured.

The Insect and its Stages

The White Pine Weevil is a brownish beetle, about one-fourth of an inch long, with irregular brown and white patches above, and a long slender beak.

The very small, watery-white eggs are placed, during April, May and June, in the pulpy inner bark of the terminal shoots, usually just below the terminal whorl of buds, in small pits bitten out by the beetle. Usually the egg-pits exude a small drop of resin and are thereby easily discovered, but when they are very numerous and closely placed many will be practically dry. The adults are readily found resting on the terminals during the egg-laying season.

The *larvae* are rather stout, legless, whitish grubs, with darker heads, about one-fourth of an inch or less in length, found during summer feeding in the bark and wood of the fading terminal shoots.

The *pupae* lie each in a chip-cocoon fashioned by the grub partly or entirely below the wood surface; they are found in the faded shoots during the latter part of the summer.

The White Pine Weevil: 1, a dead terminal, with the laterals still green; 2 and 3, egg punctures on apex of terminal, showing an egg artificially exposed at the arrow point (Enlarged).

The White Pine Weevil; adults, in the circle, and the work of their larvae, showing a dead terminal in the centre, and larval tunnels and cocoons in various stages of completion.

The Life History and Habits.

The adult beetles nearly all leave the faded tips in the latter part of the season between July and September, and pass the winter apparently in any convenient hiding-place. In the following season, during April, May and June, they may be found upon the terminals of young growth pairing and egg-laying. The eggs hatch in about a week, and the young grubs feed upon the inner bark, working downwards and more or less completely destroying the bark on the injured portion. Finally, when mature, about midsummer, they bore into the wood, penetrating to the pith on the younger wood. In the enlarged ends of the tunnels chip-cocoons are constructed, and in these the larvae pupate and later transform to the adult beetles. The young beetles bore a round hole through the bark and escape, chiefly during July and August, and hibernate until the following spring.

Control Measures

The injury by the weevil can be checked on nursery rows, in plantations, and on reproduction valuable enough to warrant the attention required. Trees between five and twenty-five feet high are attacked. The faded tops should be cut before the beetles emerge from them, and either burned or stored in boxes or barrels covered at each end with fine wire netting. The latter method is preferable since it retains the beetles while allowing the valuable parasites to escape. After cold weather comes most of the beetles will be dead and the screens may be removed, but the pine tops should be left until the following June to permit the development and escape of the larger, late developing parasites.

Two thorough collections of the fading tops, made late in June and again about the middle of July, will help materially in checking the injury, and the practice should be carried out each season as long as the trouble continues to develop. Natural reproduction near the nursery or plantation may, if uncared for, be responsible for serious reinfestation. Valuable young growth may be further protected by collecting the egg-laying beetles from the terminals. From the time the beetles appear on the terminals, in the first warm weather in April, until the middle of June, the adults may be collected and destroyed. They may be taken in an insect net by striking the bow against the base of the terminal so that the beetles fall into the net, or by holding the net against the base of the terminal and striking the upper part of the latter on the opposite side with a stick. If the trees are small a pan containing a little kerosene may be used instead of a net, and the beetles

killed as they are captured. The collection of the adults will be practical only on very valuable young trees, and the collections should be made frequently to be of much service. If made annually in nursery rows and plantations once each week during the egg-laying season, in conjunction with the destruction of the fading terminals, the practice should assist materially in reducing the annual injury. On very valuable trees in parks and private grounds the collection should be made almost daily.

TWO DESTRUCTIVE SHADE TREE BORERS

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This paper will deal briefly with two destructive shade tree borers:—

1. The locust borer, *Cyllene robiniae* Forst.
2. The bronze birch borer, *Agrilus anxius* Gory.

The Locust Borer

Wherever the handsome black locust tree (*Robinia pseudacacia*) grows, its worst enemy the locust borer, is also to be found.

Throughout Ontario and Quebec the locust trees have suffered very serious injury from the ravages of this pest. The attack is decidedly insidious and serious damage is often done before the injury is even noticed.

Life History. The life history of the insect is as follows: the adult is a black velvet beetle, about three-quarters of an inch long, strikingly marked with several yellow bands across the thorax and abdomen. It belongs to the interesting family of Cerambycidae and is, of course, long horned. In August the beetles emerge from the pupal stage and seek the nearest patch of golden rod (Solidago) where they feed freely upon the feathery blooms of this plant during the warmest part of the day. Mating occurs at once and the females, returning to the locust trees, begin energetically to search on the bark surface for crevices in which to deposit their snow-white eggs, their long prehensile ovipositors serving as the chief guide in locating suitable places for oviposition. This activity among the beetles goes on throughout August and the greater part of September. The eggs hatch in eight or ten days and the young larvae immediately start to bore into the inner soft bark where they construct cells for their winter quarters. In spring the young grubs actively resume their burrowing into the sapwood and heart of the tree, each pursuing a course somewhat at right angles to the entrance tunnel and parallel with the sides of the tree. About July the work is completed. At this time the full grown larva is about an inch long, somewhat cylindrical in shape and of a dull white color. The pupal or transformation stage is now begun and in about four or five weeks the adult beetle eats its way through the frass plug at the outer end of the resting cell and makes its escape to the exterior.

The Injury. As already seen the injury to the tree is done in the larval stage. The wounds made from time to time in the bark and sapwood often cause girdling, the branches frequently breaking off as a result of this. Where the tree is badly honey-combed it is rendered entirely unfit for commercial purposes. The healing scars on the bark surface, caused by the tree in its endeavour to patch up the injury done by the young grubs in the fall, give to the trunk an unsightly appearance and often times these roughened areas provide ground for injurious fungi to become established and permit the dampness and rot to enter the tree. The carpenter ants also obtain entrance through the holes made by the beetles and help to complete the destruction of the tree.

Control Measures. A number of experiments of various kinds have been carried out from time to time such as:—

(a) Collecting adult beetles from golden rod which had been planted especially for the purpose.

(b) Digging out the young larvae shortly after they had begun their work.

(c) Applying different washes, such as soap solution and carbolic acid, whitewashing trunks of trees, etc.

(d) Employing poisoned baits.

All these, individually, or taken more or less together have been found to give fair results. But the only sure method of control, where bad infestation occurs, is to cut the tree down and burn it.

A considerable amount of work was done last year at Ottawa in connection with the life history and control of *Cyllene robiniae* and it is expected this coming summer further valuable data will be secured, especially along the lines of control.

The Bronze Birch Borer

The birch is one of the most beautiful and most graceful of our ornamental trees and for this reason is grown extensively in parks and gardens. Unfortunately, under cultivated conditions, the various species of this tree are most subjected to the attack of its greatest and most destructive enemy, the bronze birch borer *Agrilus anxius*. Under more natural conditions, as in the forest, this does not occur.

The Injury. Throughout Ottawa city, in private gardens and on the Driveway, the work of this beetle is very noticeable. At the Central Experimental Farm, nearly all the birches in the Arboretum are affected

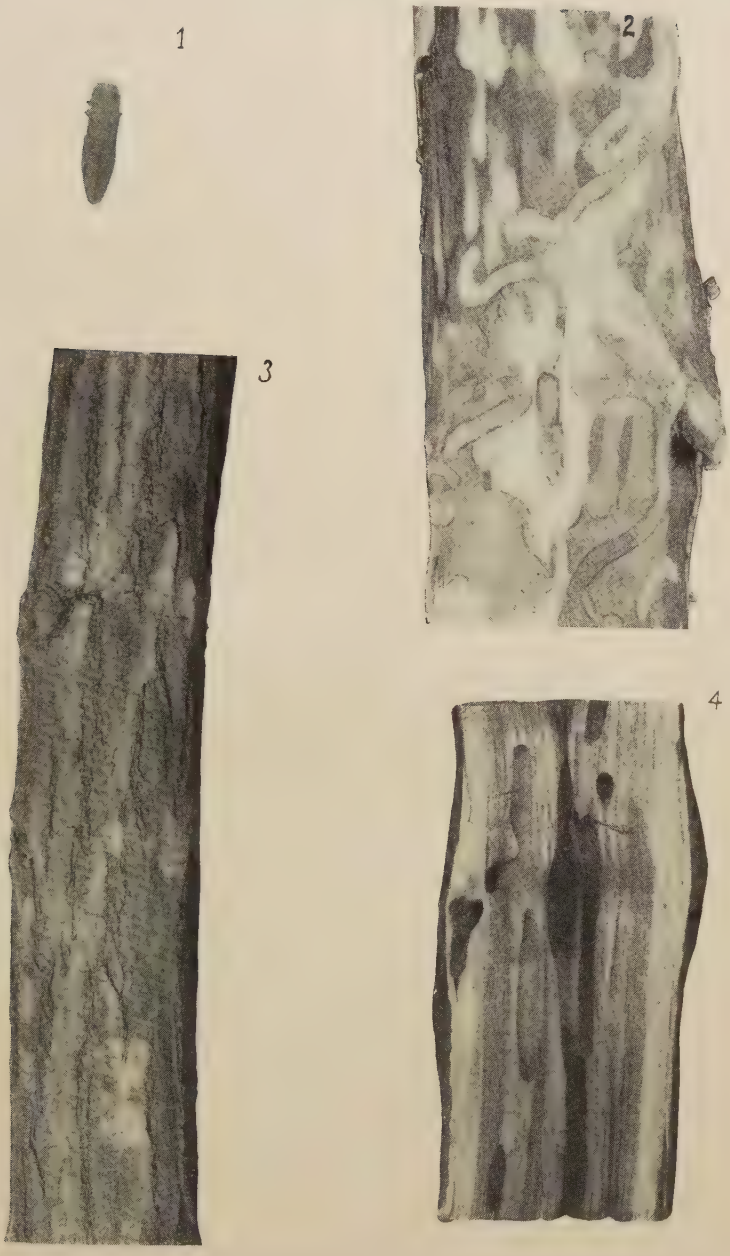


Fig. 1, The Bronze Birch Borer, adult beetle. Fig. 2, Tunnels of the birch borer grubs in white birch limb, showing a grub in its winter cell. Fig. 3, Section of a locust branch, showing eggs of the locust borer in the bark crevices. Fig. 4, Limb injured by tunnels of the locust borer.

and the larger and older trees about the residences and near the Observatory are so badly infested that it is only a matter of time before they they will all have to be cut down. As in the case of the locust borer, the injury done at first is of a very insidious character. The fight may be on in full force and the enemy well entrenched before his presence is even noticed. The insects begin their destructive work at the top of the tree and work downwards, killing the upper branches first, giving these the stag head appearance. The trunk and larger branches are then attacked and through these the larval tunnels cross and intersect one with another in endless confusion within the inner bark and sapwood. The characteristic undulations thrown up on the outer bark surfaces are sure signs of the mining operations beneath. Here and there rusty, reddish-brown patches appear on the white bark of the trunk and larger branches, indicating the presence of the borer.

Adult. The adult beetle is a small, slender, dark-bronze insect, about half an inch long and belongs to the family Buprestidae. It does not itself cause any injury, as far as is known, except that it feeds sparingly on the leaves. The time of emergence of the beetles depends greatly upon weather conditions. In the northern parts of New York State, where the winters are milder and shorter than those of Canada, the beetles are out early in May, whereas in Ottawa the time is later. Last year on account of the wet season the first adult was not seen before June 27. The holes in the bark through which the beetles emerge are of a characteristic shape, somewhat semicircular, and can be readily identified.

Larva. In June the eggs are laid upon or in the bark. The small larva on hatching begins tunnelling at once through the bark and sapwood where it forms a cell and remains quiescent for the winter in a remarkably peculiar position, the head and thorax being doubled back on the abdomen. The following spring the burrowing operations are continued and the tunnels of the different larvae at work become so inextricably mixed that it is simply impossible to follow any one particular tunnel throughout its length. The full grown larva is about three-quarters of an inch long, creamy-white, with dark retracted mouth parts. The thorax is particularly wide and may easily be mistaken at first sight for the head. A pair of dark, serrate, chitinous, barbed processess appear on the last segment of the abdomen. Their use is likely to assist the borer forward in the tunnelling process since it is exceedingly sluggish; or perhaps they act as supports on the walls of the tunnel to prevent the larva slipping backward.

Control. So far as is known no satisfactory plan of control has been devised to check the ravages of the bronze birch borer. Insecticides are

useless because the larvae are down below the surface bark and cannot be reached in this way. The only method that can be safely recommended is to cut out all infested branches and burn them at once, or certainly before May of the following year. Since the trees cannot be saved when they are found to be infested, any precautionary measures which will prevent the deposition of eggs on the trees and the egress of the adult beetles will be found to help very materially. Experiments such as washing the trunks and branches with poisoned whitewash; putting paper wrapping temporarily about the tree; spraying the foliage with Paris green (1 lb. to 100 gals. water); painting the bark with a mixture of resin and linseed oil (4 lb. resin, 1 qrt. oil to 40 gals. water) have been tried.

All these to a greater or less extent have been helpful but not radical That cure, as has been said, can only come about by the most drastic measures applying the axe or saw.

Parasites undoubtedly form a very important factor in the natural control of this insect. Birds, such as phoebes, wood-peckers, warblers and chipping sparrows also help, and more effectively too than often given credit for. Their presence in our parks and gardens should be more encouraged.

If the birches are kept in a healthy condition, free from abnormal growths, loose bark, etc., it will assist them very materially in resisting the attacks of their worst and most destructive enemy, the bronze birch borer.

THE COMMONER GRASS-MOTHS OF QUEBEC

Dr. J. A. Corcoran, S.J., Loyola College

Within the last decade or so much interest has been aroused in the study of American grass-moths. The pioneer work on the subject was published in 1894 by Dr. E. P. Felt, the present state entomologist of New York, and was entitled "On Certain Grass-Eating Insects," an admirable entomological thesis, in which the life histories and external anatomies of some twenty-six species of Crambus are found. In 1896, Dr. C. H. Fernald's classic appeared in the form of a monograph "The Crambidae of North America." In this work Dr. Fernald gives accurate descriptions and excellent coloured plates of fifty-five species of Crambus and all the species of the other genera of Crambidae which were known at his time. In more recent years Mr. W. D. Kearfoot in the "Proc. of the U. S. Nat. Mus." Vol. XXXV, and other entomologists in current publications, have described several new Crambids. Indeed, Drs. Barnes and McDunnough, in their new "Check List," give the names of sixty-eight Crambus and several species of allied genera which are unknown to those not in touch with recent work on the Pyralidae. Mr. A. F. Winn in his "Prelim. List" published five years ago by this Society, records twenty-three Crambus, two Argyria, and one Thaumatopsis as the species of Cambidae found in Quebec. Of this number, fourteen species were taken last summer on the vacant lots around Loyola College, one species, i.e., *albellus*, has not, I believe, been previously reported on the Island of Montreal.

General Characteristics

There is little likelihood of confusing the grass-moths with the other lepidoptera which frequent our pastures and meadows. Certain traits and habits make them known to even the casual observer of insects. What nature-lover has not seen a Crambus resting on a stalk of dried grass? The fore-wings are closely rolled about the body meriting for the insect the popular name of Close-wings, and long palpi project prominently in front of the head. The moths are small, the larger species have a body about half an inch in length and wings which spread perhaps an inch. The fore-wings of a general white or brownish colour, often bear pretty markings of golden, silver, yellow, brown or even black while the hind wings are of an unbroken gray or white. Delicate fringes which are frequently coloured yellow or golden, limit the outer margins of both wings and add much to the beauty of an unrubbed Crambus.

The moths as a rule fly at dusk or when the weather is cloudy, but may be "flushed" by anyone walking through a meadow even in the sunlight. When disturbed, the moths rise from the grass, fly forward for a rod or two, and settle head downwards on a stalk of dried grass, where they quickly arrange themselves parallel to the stalk. Their colours harmonize so well with their surroundings, that one may be within a foot of you in plain sight yet escape detection. They seem to have a special dislike to alighting on a level surface and will fly for a considerable distance over cultivated land in preference to resting on the bare ground. All our Crambidae are true grass-loving moths. Our pastures and meadows during the months of June, July, and August, are veritably alive with them: the lower moist meadows, as a rule, breed more species than the higher well-drained fields. Indeed, the Crambids are rarely seen away from the growing hay or pastures, and then always over a patch of grass, as on the borders of a grove or a little-used road through a wood.

Life History

All the caterpillars of our known species have been found to feed near the roots or on the blades of growing grasses and sedges, and when these are found in abundance they do not attack the grain or corn; although *zeelus* and *caliginosellus* have been mentioned in the Economic Reports from Illinois, Nebraska and Delaware as pests on corn, and *hortuellus* in the time of S. H. Scudder wrought great havoc to the young runners of the cranberry in the marshes of New England.

The female moth drops her eggs at random on the grass. The egg is oval in shape and marked by ten to twenty longitudinal ridges and numerous transverse markings, which are probably imprinted on the freshly deposited chorion of the egg's outer membrane by the cells of the oviduct. When first dropped the eggs are creamy white or straw-colored in most of our species, but in a short time they assume the deeper hues of brown, yellow or red. In *leachellus* and *innotatellus* (*perlellus*) they become bright crimson shortly before the caterpillars hatch. In size they vary in the different species and even in the same species from .3 to .56 mm. in long diameter. The eggs hatch in from five to thirty days.

The caterpillar of most of our species on emerging from the egg is less than half a line in length, the head is brown or black in colour, the thoracic shield brown, green or red, and the body straw-coloured, relieved by black or brown tubercles and a few scattered hairs. As a rule, it feeds at dusk or in the early hours of the night, and during the hours of bright sunlight it remains concealed in a nest which it spins on the blades or at the roots of the

grass. Within a few hours after emerging from the egg, the young larva, a very active creature, spins a web on a blade of grass or in the axil between the blades, and makes this its place of retreat. Later it weaves a cylindrical nest of web and entangled bits of grass on the side of a grass stalk just at the surface of the ground. As the insect grows it enlarges its nest and so always has a place of snug retreat where it may remain hidden from marauding ground-beetles and other hungry creatures. Unless sought out especially, these nests escape detection and the damage done by their occupants is rarely attributed to its proper source. A diligent search of a few square feet of grass in any meadow, will, however, usually reveal a nest or two. The larvae spend their first summer feeding when the sun is obscured, and concealed when it is brightest. At times a larva will draw the end of a blade of grass within its nest where it can eat without any fear of being picked up by a passing bird and itself being made a meal for a nestling. As winter approaches the caterpillars prepare for hibernation, *leachellus* early in August, *trisectus* in October, and most of the other species in September. Their preparation consists in extending their summer nest, a structure perhaps a quarter of an inch long, a short distance beneath the surface of the ground. Few of our species go more than an inch into the soil. As the time for hibernation approaches they feed less and less ravenously, and finally stop eating and seal the entrance to their nest with a web in which is caught shreds of vegetable matter or pieces of soil. When the grass takes on a new life in the spring, the larva awakens from its long winter-sleep, opens its nest and begins again an active life of voracious feeding. The nest is soon enlarged or a new one built, for the full-grown caterpillar of most of our Crambids is about one inch in length. As the larva reaches maturity it develops an appetite which seems to be insatiable. A few days before pupation, it throws caution to the winds and feeds continuously. It pupates in a loose cocoon spun in a burrow just beneath the surface of the ground. The period of pupation lasts from ten days to one month, depending on the temperature and the species.

There is little apparent difference in the known larvae of our Crambids. Some may be distinguished with comparative certainty by their colours but an absolute diagnosis is often difficult or impossible. When we consider that the habits, surroundings and enemies of all our species are much alike we realize that marked variations are uncalled for. Their food plants, grasses and sedges, are everywhere found in abundance, hence structural adaptations for change of food are unknown. An army of one species takes the place of an army of a related species with each new growth throughout the season.

Since the habits and life histories of the immature insects are so much alike, and the enemies of one species of these moths are the enemies of all, the mature moths of the different species show but slight structural differences, and the species of the same genus are often distinguished with difficulty. The genitalia, of course, are the most valid features but the colours and markings of the fore-wings being fairly constant in each species are more generally used as a basis for a synopsis.

We have arranged the genera of the Crambidae of Quebec according to the venation of the fore-wings—after the manner of Dr. Fernald—and the species of the genus Crambus according to the predominant colour of these wings. Since it is often difficult to distinguish gray from brown, or brown from yellow, and as the markings in more than one case give us a wing of no readily recognized predominant colour, many of the species will be found in more than one division in the accompanying synopsis. The proper position in every case may, however, be recognized since in it alone is given the size of the moth. Such a form of key, giving repetitions which may seem false or foolish to a person well acquainted with the species, has been found advantageous in many keys of phanerogamous plants arranged for beginners in botany, and should be of value to the tyro entomologist.

Key to the Crambidae of Quebec

1.—Fore-wings have veins 7, 8 and 9, arising from a common stalk, 2.

1.—Fore-wings have veins 7 arising separately from the stalk of 8 and 9.—*Argyria.*

2.—Antennae of male not plumed.—*Crambus.*

2.—Antennae of male are plumed.—*Thaumatopsis pexellus.*

Synopsis of Argyria

1.—Brilliant-yellow oblique line crosses fore-wing, 13-20mm.—*Auratella* (JU-A).

1.—Three small yellow dots cross forewing, 18-22mm.—*Nivalis* (J-JU).

Synopsis of Crambus

1.—Fore-wings are gray or brownish-gray, 2.
1.—Fore-wings are yellow or brown, 7.
1.—Fore-wings are white, 21.
2.—Fore-wings have indistinct or obscure markings, 3.
2.—Fore-wings have interspaces of veins lined, 6.

3.—Fringes of fore-wings are narrow, golden or dull-gray, 4.
3.—Fringes of fore-wings are wide, golden, 5.
4.—Cross-lines indistinct, yellowish.—*luteolellus* (J-JU).
4.—Cross-lines indistinct reddish-brown.—*caliginosellus* (JU).
4.—Cross-lines dull brownish-gray, 18-24mm.—*zeëlus* (JU).
4.—Cross-lines absent, two spots in cell, 23-24mm.—*mutabilis* (J-JU).
5.—Colour reddish, not more marked between the veins.—*ruricolellus* (JU-A).
5.—Colour brownish, veins are interlined.—*vulvivagellus* (A-S).
6.—Markings black, two cross-lines.—*trisectus* (J-JU).
6.—Markings brown, no cross-lines.—*vulvivagellus* (A-S).
7.—Markings indistinct, 8.
7.—Markings quite distinct, 9.
8.—Colour ochre-yellow, fringes same, 20-26mm.—*luteolellus* (J-JU).
8.—Colour reddish brown, fringes gray, 13-25mm.—*caliginosellus* (JU).
9.—Interspaces of veins lined, 10.
9.—Interspaces of veins not lined, 11.
10.—Interspaces of veins lined black, 23-32mm.—*trissectus* (J-JU).
10.—Interspaces of veins lined brown, 20-39mm.—*vulvivagellus* (A-S).
10.—Interspaces of veins lined yellowish brown, 16-22mm.—*hortuellus* (J-A).
11.—White median stripe absent, 12.
11.—White median stripe undivided, 13.
11.—White median stripe divided into costal and subcostal, 20.
12.—Terminal cross-line angular and single, 16-20mm.—*ruricolellus* (JU-A).
12.—Terminal cross-line angular and duplicated,—*hortuellus* (J-A).
12.—Terminal cross-line not angular.—*elegans* (JU-A).
13.—Median stripe does not touch costal margin near cell. 14.
13.—Median stripe touches costal margin near cell, 19.
14.—Median stripe unbroken to outer wing-margin, 25mm.—*unistriatellus* (JU-A).
14.—Median stripe narrows at cell, reaches margin, 16mm.—*hastiferellus* (A-S).
14.—Median stripe crossed by two brown bars reaches margin, 15.
14.—Median stripe extends two-thirds of way to outer wing-margin, 20.
15.—Hind-margin of wing paler than costal margin, 19-24mm.—*myellus*.
15.—Hind-margin of wing not paler than costal mar. 20-22mm.—*luctuellus*.
16.—White line on hind-margin of front wing, always present, 17.
16.—White line on hind-margin of front wing, never present, 18.

17.—Marginal white broken by terminal line, 21-24mm.—*pascuellus*.
17.—Marginal white broken below cell, 18-20mm.—*labradoriensis* (M-J).
17.—Marginal white not broken by terminal line.—*albellus* (JU).
18.—Dark line parallel to stripe throughout wing, 24-30mm.—*leachellus* (J-A).
18.—Dark line parallel to stripe below cell, 20-23mm.—*hamellus* (A).
18.—Dark line parallel to stripe absent, 21-25mm.—*praefectellus* (J.)
19.—Sharp tooth near end of stripe, hind-wings white, 18mm.—*bidens* (JU).
19.—Sharp tooth absent, hind-wings grayish, 18mm.—*alboclavellus* (JU).
20.—Terminal dots are preceded by black lines, 23mm.—*laqueatellus* (J-S).
20.—Terminal dots not preceded by black lines, 21mm.—*agitellus* (J-JU).
21.—Markings dark brown, terminal line curved and double, 12-15mm. *elegans* (JU).
21.—Markings, yellow, terminal line angular and single, 16mm.—*albellus* (JU).
21.—Markings, an orange and yellow longitudinal stripe, 23-25mm.—*girardellus* (JU).
21.—Markings, a few dark dots near middle and outer edge, 22-25mm.—*turbatellus* (JU).
21.—Markings, absent, both wings are a pearly white, 20mm.—*perlellus*. —(J-JU).

N.B. The size of the moth is given in millimeters to the left of the name of the species, the capitals to the right indicate the months when the moth has been on the wing in the Province of Quebec.

Of the species given in the above synopsis a few have not been recorded from Quebec, but as they are found nearby in the neighboring provinces, they have been included. *Agitatellus*, *alboclavellus*, *hortuellus*, *mutabilis* and *ruricolellus* were the most abundant forms found on the vacant lots around Loyola last summer. Dozens were frequently taken in a single swoop of the net, as many as one hundred and twenty in a minute.

Most of the Crambus are very prolific. Dr. Felt records captured females of *mutalbis* and *hortuellus* laying seven hundred or more eggs. The aggregate destruction caused by the larvae of these moths must each season be truly enormous. But as the damage is distributed throughout the growing season and each species is most destructive at a different time from the other species found in the same locality, the ravages of the Crambus are difficult to estimate.

Comparatively few of our species are of economic importance, though these under proper climatic conditions possess a capacity for causing almost total loss of our hay crop. The larvae of *vulvivagellus* and *trisectus*, in 1881, so devastated the field of St. Lawrence County, N.Y., that the loss resembled that due to an invasion of the army worm, and such indeed it was reported to Dr. Lintner. *Zeelus* and *caliginosellus* have from time to time caused great damage to the corn in various States, and the late S. H. Scudder, under the title of the "Cranberry Girdler," reported in "Insect Life" the ravages of *hortuellus* on the young runners of the cranberry vines in the marshes around Plymouth, Mass.

Many preventive measures have been suggested. The use of torches and trap-lanterns does not seem to have met with much success, all records show that comparatively few females of the most destructive species are taken at night. Deep ploughing and a change to a root crop should lessen the numbers in fields where a species has become firmly established. The first year after the campus at Loyola was seeded very few Crambids were seen on it, although the neighboring fields and lots were alive with them. Burning the dried grass in the late fall or early spring destroys those larvae which hibernate above ground, but unfortunately most of the larvae enter the ground to pass the winter.

Of the natural enemies an Ichneumon, a Tachina, and a Chalcid destroy great numbers, and insectivorous birds and predaceous beetles account for even greater numbers. But to an All-seeing Providence who dispenses the seasonable and unseasonable weather, must be given our thanks for protecting us from a serious invasion of these ever present pests.

References

Barnes and McDonnough—Check List of Lept. of Bor. Amer. 1917.

E. P. Felt—On Certain Grass Eating Insects. Bull. 64. Cornell, 894.

C. H. Fernald—Crambidae of N.A. Mass. Agr. Coll. 1896.

A. S. Forbes—14th Report of Ill. 1895

W. S. Kearfoot—Desc. n.sp. Cram, Proc. U.S. Nat. Mus. vol. XXXV 1908.

Grote—Can. Ent. vols. IX, XII and XIII.

Lintner—Inj. Ins. N.Y. 1882.

Insect Life—Vols. VI and VII.

A. F. Winn—Prelim. List Lept. of Que. 1912.

THE RISE OF PLANT PATHOLOGY IN THE DOMINION OF CANADA

H. T. Güssow, Dominion Botanist

The science of plant pathology, or the study of the diseases of plants, is one that has attracted little or no scholastic or practical attention till within a comparatively recent date in the Dominion. When it became generally realized that nearly all agricultural and horticultural crops of the Dominion suffer annually very considerable depreciations from fungous and bacterial diseases, the Dominion Department of Agriculture appointed to its staff a technical expert to direct the study of the economically important diseases, with a view to controlling or minimizing the losses caused to farmers and fruit-growers by such diseases affecting their respective crops.

In July, 1909, the Department equipped at the Central Experimental Farm a special laboratory devoted to researches along the lines of economic botany, and principally for the study of diseases of plants. The initial equipment consisted of the most essential laboratory apparatus; and, after preliminary field studies of the most important diseases in a country like the Dominion with its thousands of miles of varying climatic and ecologic conditions, it was soon recognized that a great want existed for the rendering of helpful services to the farming and fruit-growing communities of the Dominion.

For the first year or so the work was in the hands of the Dominion Botanist, and one junior assistant, with the very modest appropriation of some $2,000 per annum (excepting salaries.) Soon the more important problems began to suggest themselves, arising out of the correspondence largely carried on with interested parties, mainly persons whose crops became damaged from some disease or other.

As early as October, 1909, the zeal of the responsible officers led to the discovery of the existence of so serious a diseases as potato canker in close proximity to Canada, viz., in Newfoundland. This discovery constituted the first record of the presence of that disease on the continent of America; and, very promptly, steps were taken to prevent the introduction of this disease into the Dominion, where, it is safe to say, this persistent disease would have considerably added to the troubles of potato growers.

This discovery involved consideration of such legislative measures as would, both at the moment and in future years, adequately protect the Dominion from invasion by this and other foreign diseases. As a result, the

Dominion Department promulgated a special Act to prevent the introduction or spreading of Insects, Pests, and Diseases destructive to vegetation, assented to May 4th, 1910 (9-10 Edward VI Chap. 31), and known by the short title of "The Destructive Insect and Pest Act."

This important Act serves as a most efficient safeguard against invasion by diseases from abroad. It was soon followed (August 20th, 1912) by a similar official bill of Congress in the United States of America; so that the protection of the whole continent of America from such dangers is now fairly assured. The importance of such measures was soon recognized by the various provinces of the Dominion; and provincial Acts serving the purposes of more individual needs were promulgated by the Provincial Houses.

For some time the plant pathological experts acted principally in an advisory capacity. But soon studies of specially destructive diseases were begun, and publications were issued giving directions as to the control and prevention of plant diseases.

At the same time it was realized that one central laboratory hardly sufficed to accommodate the requirements of special cultures and their peculiar problems. Thus, when an important peach trouble in the Niagara Peninsula appeared, and Ottawa conditions were found unsuitable for the purposes of investigation, it was suggested to carry on the research work in the locality where the disease appeared. The Department of Agriculture then authorized the establishment of the first Dominion Field Laboratory of Plant Pathology—a daughter laboratory of the Central Station—at St. Catharines, Ontario, right in the centre of Canada's most important fruit-growing section.

Meanwhile the staff and appropriation increased *pari passu* with the the work and necessity for researches.

By every possible means the work of the plant pathologists was brought before the public; and, by lectures, publications, and very useful and instructive coloured posters figuring certain important diseases, the general public became more and more aware of the nature, work, and aims of this new division.

The correspondence with farmers and fruit-growers increased appreciably, and the experts became more and more familiar with the important problems demanding special attention. Soon another disease of foreign origin attracted considerable attention, the now notorious powdery scab. This disease was recorded, again for the first time on the continent of America, by the Dominion's plant disease experts.

The announcement of its discovery soon brought in reports showing it to be widespread throughout Canda and the United States, though in the latter country its wide distribution was not immediately recognized. This resulted, at first, in considerable antagonism by the United States towards the Dominion potato imports, which became objects of cumbersome and difficult regulations; at one time, even, there was a temporary cessation of our export trade with the States. While, at first, by its consequential effects on trade, the presence of this disease caused just consternation, yet it was soon realized and demonstrated that the disease was not of a character to warrant any such stringent action as in the case of the potato canker. For our own part, from the commencement, we regarded the disease as a minor one, but one which, of course, should not be allowed to inflict continued depreciation on the potato industry. Slowly more normal trade conditions supervened.

At the same time we ought not to omit stating that, in a measure, the presence of this disease proved a blessing in disguise; the interest of the growers was aroused, and demands were made for a closer study of the diseases of the potato in particular, and of other diseases in general. This eventually led to the further establishment of additional field laboratories for plant pathological research, one for Prince Edward Island, and one for New Brunswick. These laboratories have now been in operation for several seasons, and the work done by the expert officials in charge has already shown immediate and valuable results.

For instance, systematic experiments directed towards the control of powdery scab have now revealed the efficacy of certain treatments. Black leg disease of potatoes, formerly causing very considerable losses in Canada, has now been controlled so effectively, that the disease is rapidly becoming unimportant. Demonstrations of potato spraying held on numerous farms have shown the beneficial results from such treatment, both in the control of late blight and in the addition of many bushels of sound well-keeping potaotes to the normal yield per acre. Likewise demonstrations are being conducted, both on farms and in orchards, relating to the practical and economic control of diseases of all kinds.

Slowly, but surely, progress can be reported from the organizations directed towards disease control. Constant vigilance is exercised, and obscure troubles are being "nipped in the bud," or are receiving careful attention through special researches.

If one bears in mind the enormous damage caused by various plant diseases, it will be seen that the special attention devoted towards the control of same is an investment of considerable value, and serves as a

protection to the natural resources of the Dominion as well as to the harvests of the men who are making the Dominion of Canada one of the foremost agricultural countries in the world.

Since the establishment of the plant pathological survey of the Dominion as many as two hundred and seventy-four different specific diseases of economic plants have been recorded, the most common of them as many as two hundred times and more. These records, though now by no means complete, will eventually become of great scientific value, indicating the prevalence of diseases in Canada not previously reported, though no doubt ever present.

This devotion to problems of plant pathology has resulted in the closer attention now being paid to the study of this science in our universities and colleges; and it is hoped that the ever-increasing demand for trained experts for Dominion and Provincial service may soon be met from Canadian educational institutions, where courses of study are or may be placed on the curricula, fitting students for the special investigatory problems confronting them in Canada in this line.

The most recent progress to be recorded is the establishment of two field laboratories for researches on grain diseases, especially wheat rust. One of these stations is just now completed at Brandon, Manitoba, and the other at Indian Head, Saskatchewan. Both these stations will be in charge of highly trained specialists. The farming public of the West may rest assured that every care is being taken to prevent the serious losses caused by grain rust to our most important crop, wheat, which so justly earns for the Dominion its name of the "Granary of the Empire."

The present year's estimates for the work of the Division of Botany, according to authorized appropriations, amount to nearly $20,000, together with an appropriation under the Destructive Insect and Pest Act, Plant Disease Section, of $50,100.

The present personnel of the Division is as follows:—

H. T. Güssow, Dominion Botanist and Plant Pathologist.
John Adams, Assistant Dominion Botanist.
F. L. Drayton, Assistant in Plant Pathology and Bacteriology (on active service)
Faith Fyles, Assistant Botanist.
R. A. Inglis, Assistant.
Guy Dorgans, Laboratory Assistant for the Province of Quebec (on active service).
W. A. McCubbin, Assistant in charge of Dominion Field Laboratory of Plant Pathology St. Catharines, Ontario.
G. C. Cunningham, Assistant in charge of Dominion Field Laboratory of Plant Pathology, Fredericton, New Brunswick.

P. A. Murphy, Assistant in charge of Dominion Field Laboratory of Plant Pathology, Charlottetown, Prince Edward Island.

W. P. Fraser, Assistant in charge of Dominion Field Laboratory for research on Grain Disease, Indian Head, Sask.

P. R. Cowan, Acting Assistant Dominion Field Laboratory for Research on Grain Disease, Brandon, Man.

and Plant Disease Inspectors under the Destructive Insect and Pest Act:

Messrs. Geo. Partridge, Rolf Holmden (on active service),

D. E. Lothian (on active service), S. G. Peppin, W. O. Johnston, J. R. Brownlee, A. T. Tardif, and R. Trepanier.

The foregoing is merely a general statement of the establishment, organization, and progress of Plant Pathology in the Dominion during the eight years this work has been under the direction of the writer. It is proposed to follow these introductory remarks by short statements relating to the special work done by the officers in charge of the Dominion's Field Laboratories.

THE FIELD LABORATORY OF PLANT LIFE PATHOLOGY AT ST. CATHARINES, ONT.

W. A. McCubbin, M.A., Assistant in charge

In 1912 the Dominion Department of Agriculture took steps toward the solution of special disease problems, and adopted the plan of establishing field laboratories for the study of diseases and the carrying out of experimental work at a point closely in touch with the growers themselves. The first of these laboratories was placed in the Province of Ontario, and it was located in the heart of the largest fruit-growing district in Canada, the Niagara Peninsula. Because of its central and accessible situation the city of St. Catharines was chosen for the purpose, and the station started on its work here on the first of August, 1912, with Mr. W. A. McCubbin, in charge.

The first laboratory building was a small portable house 10′ x 12′ in size. It was comfortably fitted up and served very well during the summer months. It was located on the farm of the late Mr. Robert Thompson, who generously gave the use of the small site necessary, and to whom we are deeply indebted for countless other kindnesses. Later on it was found that this arrangement was unsatisfactory in many ways; the laboratory was not easily accessible to the public; board could not be found near by, and it could not be occupied in the winter time. Consequently a change was made in the spring of 1913 to the present location in St. Catharines.

The new quarters were situated on the main street of the town in a large office building, where space on an unfinished floor was secured and fitted up in accordance with plans drawn up by the assistant in charge. The laboratory consists of a large room (18 feet x 27 feet), well supplied with water, electricity, and natural gas for heating and laboratory use. It is fitted out with suitable furniture, work tables, drawers, and shelving, and a small dark room for photographic purposes was built in one corner. The equipment comprises such accessories as are needed for carrying on identification of diseases, fungus cultures, and photography, and a heated window cabinet permits the growing of any small plants needed in experiments. A projection lantern is also included, which is arranged for the use of both electricity and acetylene, and for the use of this lantern in lectures about 150 slides have been prepared to illustrate various diseases and their life histories.

During 1915 and 1916 the services of Mr. G. O. Madden, B.S.A., have been of material assistance in carrying out the work of the laboratory.

The work carried out in this station has from the beginning followed a policy which includes three main features, viz.:—

1. A general oversight of the Province with especial regard to fruit-growing localities, in order to watch for the appearance of new diseases, and to gather information concerning those already present.

2. To give all possible assistance to the growers in the control of their diseases.

3. To conduct experiments which would enlarge our knowledge of important diseases and establish adequate and practical means of control.

Bringing the experimenter close to the farm or orchard has a number of advantages. He is enabled to come into intimate and daily relationship with the growers themselves; he obtains a first-hand knowledge, not only of the diseases, but of the various local conditions which must be considered in the problem of their control. The method also allows the student to learn the life history and follow the course of development of diseases by daily contact with them—a method far superior to the short and hurried yearly trip to which necessity often restricted the early pathologists. In addition materials for study are easily procurable in sufficient quantity and at the required stages of development, and most of the experiments can be conducted on the farms or in the orchards under actual commercial conditions. Experimental work done in this way is not only very convincing to the growers but it is often an incentive to them to carry out other experiments of their own. In this connection it may be stated that the work of this

station has enjoyed from the very beginning the whole-hearted co-operation and support of the fruit-growers of the district. "Go in and help yourself," is the constant and typical response to our needs.

It is not possible here to give a detailed statement of the various problems which have engaged attention in the course of the four years during which the station has been opened, but mention is made of some few of these in which definite and useful results have been obtained. Owing to lack of time and equipment many interesting problems have had to be given up temporarily, while others are still incomplete. It is hoped that when conditions become more settled, and more assistance is available, all these deferred questions will once more be taken up.

Mosaic Disease of Tomatoes

Yearly surveys have shown that this disease is present in from 1 to 3% of all the plants grown in the district. Experiments have shown that the loss in crop in plants affected by the disease is as high as 40%. Where the disease is present to an excessive extent it has been found that it is usually carried over from the previous year in the seed bed, and that changing the earth in this seed bed will eliminate the disease readily. It is apparently not carried in the seed.

The Currant Polyporus

This fungus was found on only one currant plantation in the peninsula but it was present in about 33% of the plants in this case. It was not found to be a serious parasite, apparently drawing on its host for water supply mainly. Experiments were carried out to determine whether it could be checked or destroyed by means of chemicals. Formalin and copper sulphate were found to be promisingly useful, but final data on the value of these could not be obtained owing to the unavoidable removal of the plantation.

Peach Yellows

Considerable work on this disease has shown clearly that when a diseased tree is severely pruned or "dehorned", the growth of the succeeding year is almost without exception perfectly normal in appearance. This apparent restoration to health may last for two or even three seasons, but in the end all such trees develop the disease again. The question of the danger of using pits from diseased trees for the production of nursery stock was also investigated. Out of 1,200 pits collected from five diseased trees 8% grew and produced during the first year normal seedlings. Eleven of these seedlings showed disease at the end of the second year, however.

Raspberry Cane Blight

All the diseased canes were carefully removed from a badly affected plantation, which was then sprayed with Bordeaux mixture, (4-4-40). This treatment was followed in the succeeding spring by three other sprayings. Little if any benefit was obtained by the treatment, since the new canes were badly attacked during the ensuing summer. In another plantation the practice of cutting out all the affected canes at intervals during the summer has been followed, and this method has given quite promising results as far as the work has gone.

Peach Canker

The canker disease is quite prevalent in the peach orchards in Ontario, and it is particularly important in the Niagara Peninsula, where the ordinary orchard shows an average of 23 cankers per tree. The factors at work in producing the disease have been satisfactorily studied, and experiments have indicated a satisfactory method of control. A bulletin is now being prepared for the press on this disease.

Brown Rot of Stone Fruits

Some attention has been given to this disease from year to year. The prevalence of the spring or apothecial stage has been studied, and it has been found to be quite generally produced on the buried, fallen fruits of the plum and peach. This stage of the fungus is certainly prevalent enough to be a considerable factor in carrying the disease over the winter. The role of the "mummies" left on the trees over winter in starting the disease next spring has also been considered as a question of much practical interest. It has been found that in the warm, moist conditions of spring the dormant fungus in these mummies resumes its activities and produces fresh spores abundantly. Even if the trees have been well sprayed with lime-sulphur, the fungicide has been shown to have little or no effect in checking the plentiful production of the spores on these mummies. In addition it has been demonstrated very clearly that when the rotten fruits remain on the tree for some time, their juice passing back into twigs and branches kills and blackens them for considerable distances. From these various results it is apparent that the removal and elimination of the rotten fruits is a very important factor in the control of this disease.

The White Pine Blister Rust

This serious disease of white pines and currants was discovered in Ontario in 1914, and in the two succeeding years considerable attention has been given to it, both in an effort to determine the extent of its occurrence in the province and to collect evidence regarding some of the more important features in its life history. The work so far done has added materially to our knowledge on the following points:

1. The mode of infection on the pine.
2. The distance the spores are carried by the wind.
3. The longevity of the spores.
4. The general course followed by the disease in pine limbs.
5. The wintering of the fungus on the currant.

In addition to these specially mentioned subjects investigations are being conducted on a heart rot of peach and plum trees, the anthracnose of beans, a root rot in strawberries, black heart in fruit trees, a limb blight of maple shade trees, and various other diseases of somewhat lesser general importance.

The use of sulphur dust as a fungicide has also been taken up to some extent, and very favorable preliminary results have been secured, especially in the experiments on currant and rose mildews.

A very important phase of the work of the station relates to the identification of diseases. In many cases specimens are sent in by mail and express, but the greatest number of diseases are reported by telephone, and these reports are usually followed by a visit to the spot. These visits are very desirable since the actual conditions can be seen, besides which an opportunity is presented of discussing the case with the owner. Experience has shown that in the course of these visits a number of other troubles invariably come up for consideration as well. The help that can thus be rendered is of especial value to the very considerable number of men who have recently entered the fruit industry from other walks of life, and who are still unfamiliar with even the ordinary diseases and their treatment.

Among the numerous other activities that devolve upon this station there may be mentioned the educational side of the work. Each year a large number of addresses are given on the subject of diseases to the various fruit and vegetable growers' conventions, and to schools, public school teachers, young people's societies and clubs, Boy Scouts, etc., In 1915 and 1916 a series of illustrated addresses on the nature of plant diseases was

given to the "Short Course" agricultural classes held in the different counties of the province, and this work has been continued in 1917, with the addition of a six weeks' tour in the "Better Farming" special train of instruction sent out by the Ontario Department of Agriculture.

This station has also undertaken the field and crop inspection of potatoes grown for seed by the Ontario members of the Canadian Seed Growers' Association and though this work has been somewhat limited in extent heretofore, it is bound to become of great importance as soon as the needs of a growing potato industry establish a demand for clean certified seed, free from transmissible diseases.

In the report of the Dominion Botanist are entered each year notes and summaries of the work accomplished. In addition there is a considerable output of articles of local and immediate interest for the daily press and for horticultural journals. In 1915 a bulletin on the "Fruit Tree Diseases of Southern Ontario" was prepared, which has since been issued as Special Bul. 24 of the Central Experimental Farm.

THE FIELD LABORATORY FOR PRINCE EDWARD ISLAND AND ITS WORK

Paul A. Murphy, B.A., A.R.C. Sc.I., Assistant in charge

Situated on the Experimental Station, Charlottetown, P.E.I., the Field Laboratory of Plant Pathology for Prince Edward Island was begun in the late autumn of 1915 and was ready for occupation in the course of the ensuing winter. The idea which underlay its foundation was to have an establishment controlled by a technical officer, who would be capable of studying the diseases of crops under local conditions and of finding a remedy for as many as possible from the means locally at hand.

The Charlottetown laboratory, the second of its kind in Canada, is unique in several ways not only in the Dominion but elsewhere, for it is a field laboratory in the truest sense of the word—standing in the field and (through the interest taken in the work by the Superintendent of the Experimental Station, Mr. J. A. Clark) surrounded by its own experimental plots, and one fully equipped for continuous research work summer and winter. It is doubtful if there exists anywhere an institution as well fashioned and furnished for carrying on the work for which it was designed. Planned on

strictly utilitarian lines and with its main purpose kept clearly in view, it provides all the accommodation required at the moment without loss of neatness or dignity. The materials for its construction were obtained in Charlottetown and the building was constructed from original plans by local tradesmen under the supervision of the officer in charge.

CHARLOTTETOWN FIELD LABORATORY OF PLANT PATHOLOGY

From a reference to the ground plan it will be seen that the principal room, the laboratory, is of ample size, measuring 17 feet by 15 feet. It is provided on the northern side with three large windows, the sills of which are flush with the bench for microscopic and cultural work which extends along this wall. The work bench is more than 15 feet long, which is ample for the accommodation of three technical workers, allowing each five feet of desk room and a large window. Space is provided on a high bench running along part of the west wall for sterilizers and incubators at one end and for a sink and draining board at the other. Shelf accommodation for apparatus, chemicals and cultures is found in a large glass cupboard at the back of the laboratory on the south wall. The room is lighted by means of a strong electric drop-light near the ceiling, and numerous plugs are fixed along both benches for microscope lamps, hot plates and sterilizers.

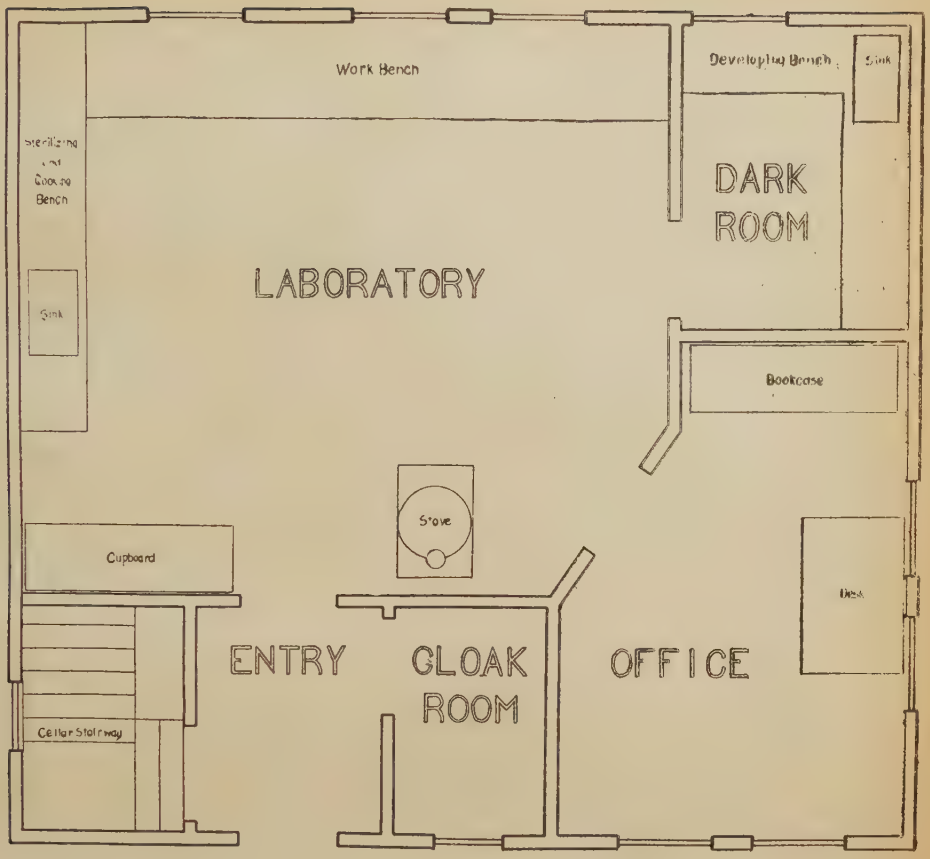
The office measures 13 feet by 9 feet and is exceptionally well lighted by four windows. There is space for a large bookcase which fits the recess behind the door, a large writing desk and a typewriter desk, leaving room for two workers, which is all that it will ever be called upon to accommodate. It is separated from the main room by a partition which does not reach to the ceiling, its height being only eight feet. This has the advantage of allowing the heat from the stove in the laboratory to reach the office more easily, and incidentally of adding to the apparent size of both rooms. A partition wall of the same height separates the dark room from the laboratory on the east, and the cloak room, entry and cellar-stairway on the south, but in these cases there is a concealed ceiling which shuts them off entirely. The dark room has a window which can be closed by means of a hinged shutter in which provision is made for lantern slide and projection work through a smaller covered opening. The developing bench, which is three feet high, is fitted with a sink, and the room is electrically lighted and ventilated after an original plan so efficiently that it never becomes foul.

The cellar extends underneath the whole of the building and has a head room of six feet six inches. It is approached conveniently from the

The Field Laboratory of Plant Pathology, Charlottetown, P.E.I , and some of the experimental plots.

(Photo by S. G. Peppin)

Turnips r ady for pulling on the farm of Mr. J. W. Calbeck, Summerside, P.E.I. Crops like this could be grown all over the Province were it not for Club Root.



Ground plan of the laboratory. Scale 1-60th.

entry, so that potatoes and other bulky articles may be brought in and removed without contaminating the laboratory unnecessarily. A block and tackle fixed over the stairway is used for lifting and lowering heavy articles. Light is provided below by four windows, and the cellar is artificially illuminated by means of two electric drop lights over the sorting bench.

In the fall of the year the space available is only just sufficient for the crops to be graded and stored. Thus to take the potato experiments alone which were controlled and carried out by the laboratory, there was involved the handling of 12,840 lbs. of potatoes, made up of over 3,000 separate lots. When it is borne in mind that this meant the careful individual examination of every tuber, of which there would be perhaps 36,000, not once only but several times in the majority of cases, it becomes clear what an amount of careful work is called for.

Apart from this a large number of experiments were carried out in other parts of the Provinces of Prince Edward Island and Nova Scotia, the produce of which was not graded at the laboratory. Some of them were done in co-operation with the farmers direct, and some in co-operation with various officers of the Department of Agriculture of Nova Scotia and the Superintendents of the Experimental Stations at Charlottetown, P.E.I., and Kentville, N.S. This branch of the work calls for the expenditure of a good deal of time and energy as the experimental fields

Potato Spraying Expt's

Charlottetown. P.E.I. 1915.

	Bush per acre	Bush due to spray	Value at 50¢
Sprayed	174	101	50.50
Check	73		
Sprayed	229	131	65.50
Check	98		
Sprayed	247	112	56.00
Check	135		
Sprayed	249	63	31.50
Check	186		
Sprayed	279	127	63.50
Check	152		
Sprayed	280	48	24.00
Check	232		
Average Net Profit			**34.38**

Type of wall chart used in the extension lectures to advocate the use of Bordeaux mixture on potatoes.

and plots extend from the west to the extreme east of Prince Edward Island and from North Sydney to Kentville in Nova Scotia. More than 75 field experiments in all were conducted by the Laboratory of Plant Pathology in the two provinces in the year 1916.

While some of these are of an investigational character and will require years to show a result, many are of immediate practical interest to farmers. Among these may be mentioned the work done on the Late Blight of potatoes and the Club Root of turnips, and, with more particular reference to Nova Scotia, Leaf Roll of potatoes and Apple Scab. Four large-scale experiments on Club Root were carried out in each province to endeavour

to utilize the natural deposits of shell mud and marl or limestone, in Prince Edward Island and Nova Scotia respectively, in checking the disease, instead of burnt lime which is hardly economical. Very encouraging results have been obtained particularly when these substances were used in large quantities and applied at least six months, and preferably longer, before the turnips were sown. Good evidence has been accumulated to show that the growing Club Root menace in the Maritime Provinces is merely an indication that the original dressing of shells or marl which all the land received once in the days of our grandfathers or fathers is in need of being renewed.

Nine field experiments were conducted on the Late Blight of Potatoes in the year 1916, which on the whole gave results equally as striking as the experiments carried out in 1915. An instructive example may be quoted to show how the best effects of spraying are not always evident when the potatoes are graded at digging time. A large plot of the variety Cummin's Pride, part of which was sprayed and part unsprayed, gave 65 bushels more per acre on the sprayed than on the unsprayed portion. This was pretty good as far as it went, but when the whole crop was picked over about a month later in the cellar the unsprayed lot had rotted to the further extent of 66 bushels to the acre, whereas only $1\frac{1}{2}$ bushels of the sprayed crop had rotted. When the crop was ready to sell off the difference in favour of spraying in this experiment stood at 119 bushels of potatoes to the acre. It was characteristic of the season of 1916 that a great part of the loss due to blight occurred as a rot in storage. This was shown in some of the experiments carried out by the laboratory in which the keeping qualities of the crop were followed up, it being found that although there might be no apparent increase in the field the benefits of spraying asserted themselves later by preventing the frequently large amount of rot which appeared in the unsprayed checks.

A considerable amount of time during the winter is given up to extension work in making known to farmers the practical results obtained. This takes up somewhat more than half the winter months, the remainder being devoted to investigation and research in the laboratory. It is clear in the present state of our knowledge that the greater proportion of time is more economically spent in extension than in other branches. Great interest is shown in the lectures which are in demand not only at the regular short courses in Agriculture of the Provincial Departments of Agriculture, but also on other occasions when they are specially asked for. Gratifying results are already apparent in Prince Edward Island, where most of the lecturing has been done heretofore, in the extension of potato spraying with Bordeaux mixture to ward off the late blight. A scheme is now

being urged whereby a number, and it is believed a relatively large number, of the largest and most up-to-date spraying machines on the market will be distributed among the more progressive of the Farmers' Institutes, to be owned and used co-operatively by the members. The difference which this movement, if successful, will make in the potato industry of the Garden Province is perhaps not easily realized at present, but its results will be far-reaching.

The reader in Nova Scotia and Prince Edward Island is referred to the occasional bulletins and annual reports of the Dominion Experimental Farms, Ottawa (which are sent regularly, free on request) for more extended information; or further details will be gladly supplied from the laboratory. The officer in charge is at all times anxious to meet farmers and to discuss with them the diseases of farm crops and their remedies. If necessary and practicable a visit will be made and the necessary advice and treatment given. Considering the short time the laboratory has been established, a surprisingly large amount of correspondence has been addressed to it. It is only by a further extension along this line that the greatest use can be made of the establishment and the undoubtedly large losses now caused by plant disease curtailed. Letters (which must be stamped) addressed to the Laboratory of Plant Pathology, Charlottetown, P.E.I., will have prompt attention.

FIELD LABORATORY OF PLANT PATHOLOGY FOR NEW BRUNSWICK AND QUEBEC

G. C. Cunningham, B.S.A., Assistant in charge

The establishment of the branch laboratory at Fredericton, N.B., was the outgrowth of the potato inspection system inaugurated by the Dominion Department of Agriculture in 1912. This inspection, aiming at preventing the spread of various diseases, particularly powdery scab, proved of inestimable value in calling the attention of the Department authorities and the farmers in general to various diseases which were causing serious losses throughout the Dominion. The importance of this step is only now being recognized. For instance, powdery scab which was promising to become prevalent in many potato growing sections, has scarcely occurred, or only very rarely, during the last two years. A survey showed that farmers who had large quantities of potatoes infected with powdery scab in 1914, have almost eliminated this trouble from their crop. In the spring of 1916 it was

only with difficulty that we were able to find 3,000 infected tubers for experimental purposes. This change for the better may have been brought about by a difference in climatic conditions, but visits to farmers whose crop previously had considerable quantities of the disease, indicate that many got rid of it by securing healthy seed, soaking it in Formalin (1 pint in 30 gallons of water) for 1½ to 2 hours, as a precautionary measure, and then planting on clean land, or land which had not grown potatoes for a number of years. This would not likely have taken place except that their attention was called to it by the rigid inspection system which was instituted. If this be true, the results have already justified the strict regulations which were in force during 1914 and 1915.

Certain experiments and observations indicate that this disease occurs generally on certain types of soil and not on others. Certain other observations show that the disease is not likely to occur except in certain localities and never seriously in the more southern sections. Just what the conditions are under which it occurs, are not definitely known and considerable careful research will be required to clear up this question.

The laboratory was established for the purpose of conducting the work of the Botanical Division in the province of New Brunswick, in conjunction with the Dominion Experimental Station at Fredericton. The work to be undertaken naturally falls under two headings: Research and Agricultural Extension. The main object will be to conduct research on diseases of agricultural crops and other botanical problems pertinent to the advancement of agricultural science, particularly in Quebec and New Brunswick.

The officers spend much of their time assisting the farmers in controlling and eliminating diseases which are injurious to their crops. This is accomplished by conducting illustration experiments and demonstrations in various sections of the province and by giving addresses before the various conventions and conferences which are frequently held.

The importance of this step is apparent in view of the great losses which are annually caused by disease. In some cases, as much as 50% of the possible potato crop is destroyed. A field survey conducted during 1916 on 100 farms in the larger potato growing sections, showed that the average loss caused by four common diseases amounted to approximately 47% of the total possible crop, or about 5,640,000 bushels, valued at $4,230,000 These diseases and the ensuing losses were:

Black-Leg, 7% or 840,000 bushels, valued at.....$630,000
Rhizoctonia (little potato disease) 5% or 600,000 bushels, valued at $450,000
Mosaic, 10% or 1,200,000 bushels valued at.....$900,000
Late Blight, 25% or 3,000,000 bushels, valued at.....$2,250,000

Some other diseases are equally injurious. Club-root of turnips and cabbages has become so serious in the Maritime Provinces that some farmers have abandoned turnip growing because of the ravages of this disease. Among other diseases which are annually causing great losses to the farmers are: Apple Scab, Apple Cankers, Anthracnose of Raspberries, various diseases of grain crops, such as smut, rust, and many others.

The Dominion Field Laboratory of Plant Pathology for New Brunswick has been established in the Dominion public building in Fredericton lately occupied by the post office and customs office, on the corner of Queen and Carleton Streets. It is centrally located in the best section of the city, surrounded by the other Dominion government buildings; post office, military barracks and officers' quarters, while in the adjoining city blocks are the provincial normal school, the city hall and the agricultural county market where farmers come to sell their products.

This situation makes the laboratory convenient of access to farmers coming to town regularly with their products, and to those attending agricultural and other conventions, which usually meet here. Fredericton, the capital of the province, is centrally located, with railway facilities to all parts of the province.

The laboratory occupies the five large rooms on the first floor, and when properly equipped will be one of the most up-to-date laboratories in the Dominion of Canada, with ample space available for future development.

The main office is 14.7 by 18.9 feet, supplying ample space for desks, book cases, filing cabinets and a large record holding cabinet, 9 feet long, consisting of drawers and cupboards.

The library and museum is 18.9 by 27.9 feet and contains 280 feet of shelf space along two walls, with considerable more room for the shelves when required. Also a large counter 3½ feet high and 15 feet long, with drawers and cupboards beneath on one side and surmounted with two book-shelves, running across the room. This serves as a current magazine table and also cuts off a section of the room for a stenographer's desk and record filing cabinets.

The library at present contains 6,800 volumes of periodical bulletins and circulars, and receives regularly all the reports and publications of the United States Experiment Stations and Agricultural Colleges, special publications of the United States Department of Agriculture and most of the Canadian publications on agricultural subjects. These are to be added to from time to time as opportunity presents itself. This is a very important section of the laboratory since at the present time no large collection of agricultural periodicals exists in the province.

The museum collection consists of specimens representing the more important diseases of economic plants and a collection of 50 varieties of potatoes secured from the Experimental Farm. These collections will be added to from time to time and it is hoped to include specimens of economic plants and noxious weeds. The general public will be admitted to this room for the purpose of studying agricultural subjects.

Opening off the library and hall are two fire-proof vaults, 4 by 7 by 10 feet, which serve as containers for records, original papers, documents and other valuable records, liable to be destroyed by fire and not easily replaced.

The main laboratory is 18.9 by 21.6 feet. In the centre of the room is a large box table, 9 feet long, 4 feet wide and 3.5 feet high, with drawers and cupboards underneath for holding equipment and apparatus. On one end of this table is a high-back sink which is very useful in plant pathological laboratories. A desk, 18 feet long, 2.5 feet high and 3 feet wide, with four sets of double drawers, providing desk space for four men allowing each man 4½ feet and two double drawers, one 2 feet by 2 feet by 6 inches, and the other, 2 feet by 2 feet by 1 foot, occupies one side of the room. A chemical case, 8 feet long, occupies the other side. It is in two sections, the upper section consisting of five shelves for holding chemicals, with a recess in the centre for protecting a set of chemical balances. The lower section which is 3 feet high and 2 feet wide, forms a convenient shelf on which to rest specimens which are in use. It contains four drawers and four cupboards for large bottles and packages.

A large electrical incubator is in process of construction which will supply five compartments, four to be 3 feet by 2 feet by 20 inches, maintained at temperatures of 20, 25, 30 and 37½ degrees centigrade, respectively, and a large compartment at the bottom, 6½ feet by 2 feet by 20 inches, cooled by running water, to serve as a refrigerator. This incubator should give every satisfaction, and will be one of the few similar in America.

Adjoining the main laboratory is a second room, 12.9 by 18.9 feet. This room contains a large bench along one side for conducting chemical tests of importance in relation to plant diseases; a large, high-back, cast iron, white enamel sink, 20 by 36 inches, with hot and cold water connections; and a series of five shelves, 18 inches wide and 12 feet long, for holding stock supplies of apparatus, etc.

A dark room, 6 by 10 feet, with a large sink, two cold water taps, two drain boards, and a compartment shelf consisting of twenty-six compartments for holding supplies, negative photographs and photographic equipment, has been built in this room.

With the exception of the large desk in the main laboratory, which is made of birch, all other desks, tables, cases, shelves, etc., are of black ash, the tops of tables, etc., being of black walnut. The rooms are all well lighted and supplied with electricity. The chief deficiency is the absence of either natural or artificial gas, which it is very desirable to have in a plant pathological laboratory.

The foregoing sketches will convey some idea of the establishment and present organization, which have been achieved during the seven years of my office. I am greatly privileged in having enthusiastic and able colleagues associated with me in this work; and, in the pleasant relationship that has always existed among us, we have every hope for future progress. Soon the field laboratories will require additional assistance, and it is hoped that Macdonald College will supply its share of young pathologists to the country. The gradual extension aimed at will ultimately cover the whole Dominion, and a survey will become possible, which is sure to be of the greatest economic importance to the country. This has been my aim from the commencement, and, whether or not my sincere efforts have succeeded, I leave to my critics to say.

ANIMAL PARASITES AND RURAL SANITATION

Dr. Wm. A. Riley, Cornell University

When your worthy secretary asked me to speak before you this evening it seemed, at first, that the subject of animal parasitism and its relation to sanitation hardly had a place on the program of a society devoted to "the protection of plants from insects and fungous diseases." On second thought, I justify the invitation and my acceptance on the grounds that the development of rural sanitation is one of the most important factors in the safeguarding of the man and his family who must be directly responsible for the protection of our agricultural products. I hope to show that in the development of a rational sanitation the study of the life histories and the biology of animal parasites is of prime importance.

In taking up our subject it is necessary to define what we mean by the term "parasite." This is not so easy as might, at first thought, appear. It is often said that "a parasite is an organism which lives at the expense of another." A little consideration will show that this definition is equally applicable to a predatory species or, in its broadest sense, to *all* organisms.

For the purpose of our discussion we may say with Braun, that;

"A parasite is an organism which, during the whole or a part of its life, lives on or in the body of another organism, from which it obtains its sustenance."

The infested organism is known as the *host.* In the case of many parasites, a sexual stage is developed in one species of animal, and an asexual stage is developed in an entirely different host-species. In such instances we refer to the animal in which the parasite appears in its sexual form as the *primary host.* The one in which the asexual stage of the parasite occurs is the *intermediate host.*

Of the many parasites which infest man and animals we shall consider only those belonging to the animal kingdom and we shall still further limit ourselves to a discussion of a few of those commonly referred to as "worms."

The terms "parasites" and "parasitic worms" awake in the popular mind only feelings of disgust and loathing. To the zoologist it is quite different, for he soon loses all other feeling in one of amazement and appreciation of the wonderful life histories of these animal forms, the amazing ways in which they adapt themselves to their environment, and the devices by which they are enabled to hold their own in the struggle for existence.

It is too much to expect that the layman will adopt the zoologist's viewpoint, and it is not necessary that he should. But it is of vital importance that there should be a more widespread diffusion of knowledge of the life histories of the species commonly attacking man and animals, and of the methods by which they are perpetuated and spread. Only through such knowledge can injurious species be combatted, and only through popular education can rational measures of sanitation be enforced.

That there is need for such education may be readily seen when we consider the evidence which we have as to the medical importance of these forms. It was only a few centuries ago that medical men attributed a large share of human ills to intestinal worms. A relic of the same belief is seen today in the popular inclination to blame most of the disorders of infancy to "worms."

The recognition of the role played by bacteria as the cause of disease, and the development of the germ theory during the latter part of the past century contributed largely to the swinging away from the belief in the medical importance of the parasitic worms and, as is usual under such circumstances, the pendulum swung too far. For a time, many prominent medical men regarded such parasites as insignificant, or even as innocuous.

Our views have had to undergo readjustment and while we now laugh at the extreme beliefs of the mediaeval physicians, we nevertheless recognize the danger of the viewpoint which ingores the grosser parasites as causes of disease and even death of their host. There is today no question among students of the subject but that many such parasites must be seriously reckoned with as a menace—direct or indirect—to the individual and to the community.

The ways in which internal parasites may cause injury and disease to their host are varied.

1. They may constitute a drain on the nourishment of the infested animal. This, popularly supposed to be their chief action, is in reality very subordinate. Even when they occur in large numbers it is not possible to explain the effects produced as merely due to malnutrition.

2. Mechanical disturbance, due to large numbers of the worms, or to their presence in more limited numbers in certain organs, may cause serious injury or even death of the host. Thus, a common roundworm of poultry occasionally occurs so massed as to plug the intestines of the bird. Similar difficulties have been caused by the large round worm, *Ascaris lumbricoides*, in man. A single cyst of the gidworm, *Multiceps multiceps*, in the brain of a sheep may cause the animal's death.

3. Nerve-irritation from the presence of parasites may manifest itself in various ways. The presence of the giant nematode *Dioctophyme* in contact with the diaphragm of a dog set up spasmodic vomiting. Itching of the nose is a reflex nervous symptom associated with the presence of certain parasites of the alimentary canal of children, while in extreme cases convulsions and epileptic strokes may be likewise produced.

4. The production of specific poisons or toxines by parasites is one of the most important ways in which they may bring about injury to their host. It is now clearly established that the evil effects of hookworm infestation are attributable not to its direct attacks but to the actions of such toxines. Various species of tapeworms have been shown to affect their host by similar products. Thus, Schaumann and Tallquist, 1898, fed to a dog fragments of the fish tapeworm, *Dibothriocephalus latus*, which is known to cause anemia in the human host. The result of the experiment was the reduction of the red blood corpuscles of the experimental animal from a normal of 3,400,000 to 1,200,000 per ccm. This haemolytic action of the worm was then similarly demonstrated *in vitro*. Many other illustrations could be cited, all emphasizing the importance of this toxine-producing power of internal parasites.

5. Finally, centers of infection may be produced by the incidental injuries caused by the feeding or migration of parasites. Lesions of the intestinal mucosa may permit the entrance into the circulation of typhoid or other germs which might have passed through the canal without ill effects. Certain types of appendicitis are clearly indicated to be associated with the presence of whipworms (*Trichuria trichuria*). Migrating trichinae have been found to carry with them pathogenic organisms causing abscess and septicaemia. Of special interest in these days is the fact that parasites may stimulate abnormal tissue growth in their host and that there is excellent evidence that they may occasionally induce cancer.

Having seen that the parasitic worms must be reckoned with as important foes of man and his domesticated animals, we may now examine more closely the groups concerned and some typical life histories. This will serve to illustrate that methods of control of parasitic forms must be mainly preventive, and that a knowledge of life-histories affords us the only clue to vulnerable points of attack.

The parasitic worms of man and animals belong almost exclusively to the two great groups of *Platyhelminthes*, or flatworms and *Nemathelminthes*, or thread worms. These groups are well known to all of you and we need only recall that the parasitic flatworms include the *Trematoda* or flukes, and the *Cestoda*, or tapeworms. The threadworms are of two classes,

the *Nematoda*, which includes by far the major part, and the *Acanthocephala*, which are characterized by the possession of a protrusible proboscis covered with many rows of recurved hooks. Without attempting to limit our discussion to the most important parasites of man, we shall select a few readily available forms to emphasize typical life histories.

The Trematoda, or flukes, we may dismiss with scant attention, for they are *relatively* unimportant for both man and the higher animals in this country. Imported cases of human infestation have been occasionally reported for the United States. Immediately following the World's Fair in Chicago, in 1893, a group of Boer soldiers, who had been on exhibit on the Midway, toured the United States. Examination showed that several of these men harbored the blood fluke *Schistosoma haematabium*. I have found the related species, *Schistosoma mansoni*, in a Porto Rican student at Ithaca, N.Y., and there are several other records of its occurrence in the United States. My assistant, Mr. W. L. Chandler, and I have found concurrent infestation with two liver flukes, *Clonorchis sinensis* and *Opisthorcis felineus*, in a Japanese student. The lung fluke, *Paragonimus westermanni*, has similarly been found in this country in Japanese, Coreans, and Chinese. It is more than possible that some of the trematode parasites of man will ultimately become established in this country.

The Cestoda, or tapeworms, almost without exception must infest two different species of animals in the course of their life hisotry. The asexual stage is developed in an intermediate host which, typically, is preyed upon by the primary host, in which the sexual stage of the worm must develop. Thus, to know the origin of a tapeworm which we find in its mature state in an animal, we must study the food of the host and, as we shall see, the ectoparasites which attack it.

A good illustration of this life cycle is afforded by a very common tapeworm of cats, *Taenia crassicollis*. The immature stage occurs as a round, cream-colored cyst about the size of a pea in the liver of mice (fig. 1), rats, and certain other rodents. Within the cyst is the head of the future tapeworm, with a body one-half inch or more in length (fig. 2). When the infested mouse is eaten by a cat, the cyst and the body of the larval form are digested, the head attaches to the intestinal mucosa and the adult tapeworm promptly develops. The specimen before you was secured by feeding infested rat liver to a young kitten, free from other intestinal parasites, and the mature worm was recovered in a little over six weeks' time. Ripe segments filled with eggs are passed by infested cats, the eggs are scattered and taken up by mice and other rodents, and these in turn develop the cysts and become capable of passing on the parasite to their hereditary enemy, the

cat. The white mouse, which you see (fig. 3), is a laboratory reared one which accidently picked up apparently a whole segment of the mature tapeworm. Instead of developing the one to three or four, or a limited number of cysts, which we ordinarily find, it developed the myriad represented by the little rounded areas and the result was fatal.

Just as one of the commonest tapeworms of cats is the species which passes its immature stage in the mouse or rat, so the commonest one of hunting dogs is a species, *Taenia serrata*, which develops its cystic stage in the rabbit. Eggs which are scattered by infested dogs on herbage are swallowed by rabbits, and develop as cysts in the body cavity of these animals (fig. 4). The infested rabbit, or its viscera, are eaten by dogs and the mature worm develops in them. They in turn pass the ripe segments (fig. 6), and eggs are scattered to be taken up by rabbits. Thus the cycle continues in nature.

I was careful to refer to this last species as one of the commonest tapeworms of *hunting* dogs. Still more common in pet dogs and in cats is the so-called double-pored tapeworm, *Dipylidium caninum* (often referred to in medical literature as *Taenia cucumerina*). The reason for its occurrence in these animals is understood when we learn that this worm has as its intermediate host the dog louse or the dog flea. In these insects, whose larvae have fed upon eggs from the infested dog, the minute larval tapeworm develops. So minute are these that as many as fifty have been found in a single dog. Rather rarely this tapeworm has also been found in humans. When we consider that it can only develop in one who has swallowed the intermediate host of the worm, it is not surprising that most of such cases have been of children. A possible method of infection is illustrated by fig. 7, a photograph whose charm is lost when we consider it from the viewpoint of parasitology.

Another instance of insects serving as intermediate hosts of a tapeworm of man is afforded by *Hymenolepis diminuta*. This ordinarily occurs in its sexual stage in rats and mice. The eggs are dropped by these hosts and develop the asexual stage in various grain-infesting insects. These taken up by rats and mice pass on the infestation. Man becomes infested by ingesting the insect-host in imperfectly cooked cereals and similar foods.

The best known of the tapeworms of man is *Taenia saginata*, which may attain a length of thirty-five to forty feet. It has been estimated that a single one of these worms may produce 150,000,000 eggs within a year. These, when taken up by cattle, develop into the cystic form. Man becomes infested by eating raw or imperfectly cooked beef containing these cysts. These develop into the sexually mature worm in from two to three months.

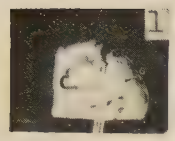
Another large tapeworm of man is *Taenia solium*. The chief intermediate host of this worm is the hog. Pork or beef infested with cysts of tapeworms is spoken of as "measly."

These must suffice for illustrations of life histories of the Cestoda of man and the higher animals. It will be seen that in all cases the eggs developed in the primary host are scattered with its excrement and that they must then be swallowed by another species of animal—the secondary host—in which they undergo development before they are capable of reinfecting the primary host.

With most of the *Nematoda*, or threadworms, affecting man this is not the case. Before taking up other illustrations however, we shall consider one of the most important nematode parasites which, like the tapeworms, must pass through two hosts in completing its development. This is the trichina worm (*Trichinella spiralis*), the cause of the serious and often fatal disease of man known as *trichinosis*. The larval worms live coiled up in lemon-shaped capsules in the muscle of man, pigs, rats, and various other animals. When man feeds upon infected pork the larvae are liberated and develop as mature male and female forms in the intestine of their new host. After fertilization the females produce enormous numbers of living young, which migrate to the muscular tissues and there in turn become encapsuled. The natural reservoirs of the parasite are probably rats. These become infected through eating the offal and scraps of infected meat about slaughter houses, and, being cannibalistic, they afford an easy means for the development and spread of the trichinae. I have found as high as sixty per cent of the rats taken at a local slaughter house to be infested.

Probably the most common of the parasitic worms of man, the world over, is the so-called eel-worm, *Ascaris lumbricoides*. It is also, with very rare exceptions, the largest, the mature males measuring about eight inches and the females up to fifteen inches in length. In their fresh condition they somewhat resemble an enormous earthworm. The eggs leave the body of the host with the feces, and scattered by wind and rain, they develop an embryo which may remain dormant for many months, or even for years. Sooner or later some of them may be swallowed by man, in water, salads and other uncooked vegetables, or from dirty fingers. Then in five or six weeks the embryos develop into adult worms, and the eggs are again scattered broadcast.

A common nematode worm of man is the "pinworm," *Oxyuris vermicularis*. It is this worm that is usually meant in speaking of "worms" in children, though statistics show that it is less abundant in this country than has been commonly assumed. The males are about one-fifth of an inch in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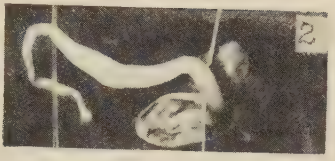
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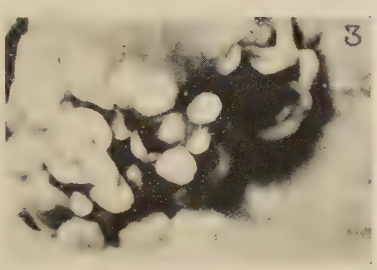
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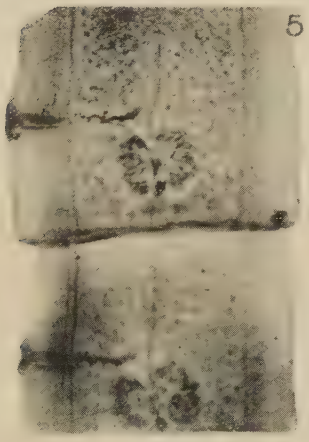
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length, while the females are nearly one-half inch. They produce enormous numbers of eggs which, like those of the eelworm, are passed with the feces, and are scattered everywhere. They are taken up by children and others in the same way as those of the eelworm. Eggs of both species may be transported by flies, as well as by more direct contamination to food, candies and toys, and thus be swallowed.

In the instances so far cited the parasite gains access to its human host by a *passive* transfer, *i.e.*, the eggs are accidently scattered and are taken up with food or drink. In the case of a number of nematodes the transfer is an *active* one, the young worm burrowing into its final host. A notable example of this method is afforded by the hookworm, so prevalent in the southern United States. Infested individuals scatter the eggs by soil pollution, they develop into larval forms, and these actively attack new individuals, boring into the skin of the feet or other parts exposed, and finally reaching the alimentary canal, where they become sexually mature, and a further source of soil contamination.

We have cited but a few typical illustrations of life histories of internal parasites of man and animals. These examples might be many times multiplied but enough has been said to show that such parasites constitute a distinct menace to the health of man and his animals, and that they are propagated and spread by general insanitary conditions. The one basic principle on which the control of parasites rests is *cleanliness*—cleanliness of the individual, cleanliness of his surroundings, cleanliness of the community, and cleanliness of the more remote sources of food supply.

Parasitic infestation in many cases means nothing more or less than the swallowing of human excrement with accompanying eggs of parasites which are able to develop without passing through an intermediate host. We have seen that the contaminated matter may be conveyed directly from soiled fingers, or food handled by such fingers, or that it may be taken in with food or water which has been more indirectly contaminated. This is not a pleasant thought but it is essential that it be realized if progress is to be made in the control of diseases of this type.

Thus a prime consideration in rural, as in urban, sanitation is the proper disposal of human excreta. All too often this need is ignored and in the vast majority of cases the best that is attempted merely serves to render the waste less directly offensive. Conditions such as are shown in figures 8 and 9, from a publication by Dr. C. W. Stiles, 1910, are not in the slightest degree exaggerated, but can be matched in any community. Yet, short of no arrangements whatever, it would be impossible to devise any more efficient way for the natural spread of intestinal diseases and parasites.

Not only are the forms which develop directly disseminated in this way, but those which, like the tapeworms, must be taken up by an intermediate host, find ideal conditions for their development here. The illustration well shows how hogs might become infected if any of the occupants of the farm harboured the pork tapeworm. Cattle would pick up the eggs of the beef tapeworm from contaminated herbage.

A striking instance of infestation of animals from defective sewage disposal was reported by Dr. B. H. Ransom, in 1913. Three lots of cattle from the same locality had shown a very high infestation with cysts of the beef tapeworm. Examination of the surroundings under which they had been kept showed that "(1) the intake of the water supply for the cattle troughs was in a small river 75 yards below the outlet of the sewer from the city where the cattle were being fed; (2) in the cattle yard was a stagnant pool which was the only water the cattle had to drink when the regular supply was frozen, as it frequently was during the winter, and this pool received the drainage from an area containing the privies of the establishment where the feeding was done and from that part of the city where soil pollution existed; (3) the cattle were fed cotton seed hulls which were more or less contaminated with human feces, as it was a common practice of the employees of the establishment to defecate in the buildings where the hulls were stored."

"An extreme case," it may well be pronounced and yet it is not altogether too suggestive of conditions about many a farm home where, added to the insanitary privy and defective drainage, there is almost always pollution by human excreta about the barns and the straw stacks.

Such conditions emphasize the importance of proper inspection of meat supply from farms and local slaughter houses. A few years ago there was a great furor in the United States over conditions in the great packing houses, and as a result, many important reforms were brought about. As a matter of fact, the danger from such sources is vastly less than it is, carcass for carcass, from the local slaughter house. The animals reared on the great cattle ranges are much less likely to be infested than are those reared on the average home farm. It is a popular theory that locally grown and butchered meats are the safest, but this is wholly fallacious, unless they are marketed under a system which allows for a rigid inspection and for condemnation of that which is unwholesome.

Nor are meats the only food products which from the viewpoint of the parasitologist should be subjected to supervision and to proper regulations for the purpose of preventing contamination. All ready-cooked foods, and fruits and vegetables which may be consumed uncooked, must be protected

against the dangers from soiled hands, filthy rinsing water, exposure to street dust and dirt, and from flies, which may carry the eggs of parasites as well as the germs of intestinal diseases.

None of these measures will of themselves suffice. The housewife must realize the importance of sterilization by thorough cooking, when possible, and of the most painstaking cleaning of vegetables and fruits which are to be eaten without cooking.

Pet animals must be reckoned among the important agencies through which man may be infested with certain parasites. It is well known that the source of house fleas in this country is the dog or cat which is allowed the freedom of the house. We have cited the illustration of the tapeworm which is sometimes transferred from cats or dogs to children, and a number of others could be mentioned. Without entering further into detail, we may say that there is a long list of both external and internal parasites of common domesticated animals, which may through them be conveyed to man. We must not let our love for the faithful dog or for other domestic animals blind us to the fact that modern sanitary knowledge demands a change in the public attitude towards them.

Finally, there is need for a more widespread understanding of the conditions under which animal parasites, as well as bacterial diseases, are maintained and disseminated. Sanitary measures cannot be enforced until such knowledge prevails among the masses. Enormous strides in this direction have been made in the last few years. Let us do our part towards bringing about still greater advances in the future.

Explanation of Plates

Fig. 1. A portion of the liver of a mouse, showing a cyst of the cat tapeworm, *Taenia crassicollis*. Natural size.

Fig. 2. A more mature cyst, from which the larval tapeworm has been extruded by pressure. Natural size.

Fig. 3. A portion of the liver of a white mouse, showing very heavy infestation with the cysts of the cat tapeworm. Natural size.

Figure 4. Cysts of a dog tapeworm, *Taenia serrata*, in the body cavity of a rabbit. Natural size.

Figure 5. A portion of two mature segments of *Taenia serrata*, from the dog, showing the reproductive organs. Magnified 12 diameters.

Figure. 6. A single ripe segment of *Taenia serrata* from the dog, showing myriads of eggs ready to be scattered. Magnified 12 diam.

Fig. 7. One of the ways in which parasites may be transferred from animals to children. Illustration from Riley and Johannsen.

Figs. 8 and 9. Types of insanitary privies all too common. They furnish ideal conditions for the transmission of intestinal parasites and such diseases as typhoid and dysentery. Illustration from Stiles, 1910.

A FUNGUS CLUB ATTACKING THE OAK SCALE

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The soft scales or Lecaniums attack shade, fruit and forest trees, as well as various greenhouse palms, crotons, ferns and begonias . The European fruit scale or New York plum scale and the terrapin scale have proved serious, though usually local, pests in favorable seasons.

The Lecaniums have a soft shield or oval-shaped body protected by a scaly covering of various shapes. At first active, the insect soon after hatching settles down to feed and usually loses legs, eyes and feelers. On the under side of the body the head carries a long piercing beak, or sucking mouth like a six-lash whip.

The tip of the beak is sharp and saw-like, and when a favorable place for feeding is found the scale thrusts the beak into the juicy tissues of the host plant. The sap is sucked out and the plant weakened, or is poisoned by the attack. Leaves, twigs, and small stems are attacked.

Young scales produce a sweet sticky honeydew, which falls to the ground below. The sooty black fungus that grows on the honeydew gives infested plants a dirty unhealthy appearance.

When mature, the male insect develops a pair of wings, crawls out from under the scale, and is active. In spring, the sedentary female lays from a few to 2,000 eggs under the scale, where they may be found filling her shrivelled body.

In the fall of 1916, a swamp white oak was noticed near Ste. Anne de Bellevue infested by a soft scale, closely resembling in gross and microscopic appearance the Oak scale (*Lecanium quercifex Fitch*). Many of the scales showed signs of a fungus which had thrived upon the body of the scale, fruited, and produced spore-bearing branches. The scales were covered, some of them, with these tiny club-like stromata or projections, each 1.75-2.0 mm. high, with a head to the club 0.3 mm. thick, rather obovate, brownish-gray, rising on a very short handle or stripe, ashen gray in color. The stromata or clubs grow, some from the sides, but mainly from the dull black dorsal surface of the scale. The fungus in hand sections showed no perithecia or spore cups. The description agrees with that of the Gray Coccus Club (*Cordyceps clavulata Schw.*)

It is uncertain whether this Cordyceps is a fungus parasitic on living, or saprophytic on dead scales. Only dead scales show the fungus, and it

probably destroyed them. The May beetle, sphinx moth, mason wasp and some cicadas are all known to succumb, while larvae, to various fungus clubs (*Cordyceps* sp.).

Attempts by V. Tubeuf to infect caterpillars with *Cordyceps militaris* failed of success,[1] as did those of Franz Tangl with the nun moth in 1892, when tried in the field. The work of Billings and Green Glenn (1911) on the white fungus disease of chinch bugs, and of Morrill and Back (1912) on three fungus parasites of the Florida citrus grove white fly, show that spraying the crop with spore emulsions has little more effect than introducing the fungus, and fails to spread it.

More hopeful results obtained by Speare and Colley (1912) in spreading the brown tail fungus show it to be a factor in the control of brown tail moth. As in the case of the chinch bug and white fly diseases, favorable weather is required. This is found in Massachusetts in spring, early summer and fall. On warm moist nights favorable results may be expected. The autumn seems from experience the best time for infection. The brown tail fungus is said to be "used effectively in the spring and early summer, when the larvae have left their nests and in the autumn for several weeks before the webs of the new broods are closed for the winter. During both of these periods the rapid spread of the disease is largely dependent on weather conditions, and when these conditions—warm nights and damp atmosphere—favor the growth of the fungus, artificial distribution yields truly satisfactory results, and may bring about enormous and widespread destruction." As much as 63 to 100 per cent of the brown tail caterpillars may be destroyed, and though no "cure-all," a useful means is here indicated for checking the brown-tail moth. Further work may show that other fungal diseases may be spread among destructive insects.

REFERENCES

[1] Cook, M. C. Vegetable Wasps and Plant Worms.
[2] Glaser, R. W. Jour. Econ. Ent. 7, pp. 473–476, Dec., 1914.
[3] Thro, W. C., Bull. 209, Cornell U. Agr. E. S.

FACTS ABOUT WEEDS AND INSECTS

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In order to accede to the desires of our devoted President, I shall call attention to a few enemies of plants which I have seen at work this year. My observations cover a very limited territory, consequently the conclusions must not be generalized. Moreover, I have had but little time at my disposal and thus many little robbers may have accomplished their work of devastation without my knowledge. The fact that I have not seen them does not prove that they have not kept busy. I shall begin by a few plants and continue with a few insects.

Plants

Towards the end of June I noticed that the race of dandelions was not likely to die out soon. At all events, if the seed gives out, one has but to betake himself to the neighborhood of Boucherville and the islands opposite. Even from a long distance away most of the fields at blossoming-time have the aspect of an immense yellow carpet. One would imagine that there were no other plants besides this one. Without energetic action, I fail to see how the dandelion can be destroyed, and this all the more since by its early blossoming it has already scattered to every wind millions of seed before the other plants are ready for the sickle. Its propagation then seems assured.

I call attention also to the buttercup and the ox-eye daisy. I should never have imagined that such plants could have been tolerated, and this in the circumstances I shall name. In early July I have followed them from Montreal to Bout de l'Ile; then from Montreal to Montfort Junction, then along the C.N.R. To be sure, all along the journey, one could make a very decent collection of the worst noxious weeds—here the wild mustard predominating, there the thistle and chicory. But that which first of all intrudes upon the traveller's sight is the enormous quantity of buttercups and daisies. It is difficult to say which of the two plants counts the most individuals: in certain spots the buttercup takes the lead while in others the daisy has the upper hand. Near the railway the daisy has generally the advantage, but the buttercup on the other hand spreads over a larger surface. This is particularly noticeable in certain places recently settled in the Laurentides. Not a field, not a road free from the buttercup and not rarely is the daisy found as its companion. It is clear that these plants

everywhere accompany the settler if he is not careful. Why be at such pains to move far away only to cultivate the buttercup and daisy on the rocks? It is evident that the railroads have infested their own lines whence the seeds scatter into the adjoining fields. However, many distant localities, difficult of access, some even accessible only by the lakes, are already invaded by hundreds of plants. This can only be explained by bad seed. In this case the buttercup always predominates. It would be expedient to make greater efforts to convince the farmers of the harm done by these weeds. Many do not even suspect that the evil exists. Generally poor and with but scant knowledge they have gone out to clear new land, then have sown it but with cheap seed dear at the price they paid for it. It seems to me that it would be a work of national welfare if the Government could furnish good seed at the price of commercial seed. The Seed Department at Ottawa would doubtless be ready to do this, but many are not aware of this and not a few imagine that the intention is to rob them or to bribe them with a view to the elections. Before passing from colonization roads to other matters I would call attention to the orange hawk-weed. It has taken firm foothold near the C.N.R. at no great distance from Montfort. What a pity that this should be a noxious weed for it serves as a beautiful decoration to the outskirts of a forest. The passengers who are unacquainted with it except for its face admire it willingly and take advantage of the occasional stops of the train to seize a flower. Would that they might gather them all! Were it not for its invading roots it would be an easy matter to get it under control for it has not yet spread very far from the railroad, but three or four miles. But in certain places it is very plentiful while in others are to be found but a dozen plants or so, probably sprung from a single seed that the trains or even the passengers had dropped there. The infested lands will not be settled to any great extent owing to the essentially rocky nature of the country. In any case, the farmers will have to watch, for it travels rapidly.

But let us return nearer to Montreal. We shall again meet our buttercups and daisies. Not only is it a pity but a shame as well to see all the farms east of the city so completely overrun. On both sides of the railroad tracks to Bout de l'Ile nothing is seen but white and yellow—daisies and buttercups. Wild mustard is rarely absent, while on certain farms it predominates. But that which strikes the eye first of all is the marvelous prevalence of daisies and buttercups. Are all these uncultivated fields, or the property of lazy men? Few or no vegetables, rarely crops of any kind, so that one would take them for abandoned farms. Here a few cows whose tails stir the daisies that hide them, there some children gathering berries; no workmen about or next to none. Here and there a farm with

its green fields breaks the monotony of this coloured expanse. In cultivated districts mustard seems most abundant because the daisy and buttercup have diminished; this shows that the two last-named plants could be controlled with the exercise of sufficient care. But who would be willing to undertake this task? Without general action the work would be useless. A piece of property surrounded by abandoned fields will not escape invasion. A farmer who respects himself, not daring to cultivate such fields at the very door of the city, will leave. I believe that many have thus gone away. In truth what do we find cultivated east of our big city? Bill-boards; horrid bill-boards supported by a frame-work anything but artistic. And you may be sure that they grow thickly. They advertise a thousand marvels—they offer the best in the world at the lowest price. Not a few offer you, for really nothing, the land on which they bloom. But now to the point. All these lands were bought up at the time of the boom in real estate. They were then put up for sale. From that moment there was no longer any place for the farmers. In the meantime, until these lands are sold, the noxious weeds are making the most of their opportunity. A wonderful advertisement indeed for our city, these fields of yellow and white. Is the soil poor? It is the soil of the Island of Montreal formed by the pleistocene deposits. Thick in places, in others it measures but a few inches on Trenton limestone. This is the soil found in the gardens adjoining the city. If you doubt its value, go and see it; you will easily recognize the poorer spots by the height and colour of the plants. But when you see wild mustard from three to four feet in height and resembling shrubs; when you see the buttercup and tall daisy hiding calves four months old, you may conclude that the soil is not poor. Consequently it could be made productive located as it is near the city, near an inexhaustible source of fertilizers. It would be well adapted to intensive farming and in the spring could supply the markets and replenish the purse of the farmers. But it is preferable to produce advertisements, this being less troublesome. Is this the fault of the land? Will it wait until the real estate madness returns to have the bill-boards replaced by houses? If so, it will wait a very long time. We know, moreover, that it is not the rise in real estate that will greatly multiply construction. If the land increases in value, it is useful for speculation; it is bought and sold, to be bought and sold again. Thus the change is only in the advertising, which change is prejudicial neither to the buttercup nor daisy.

A few farmers remain, however, and these have a right to self-protection. Moreover there are laws with regard to noxious weeds. Should not all owners of uncultivated lands be forced to cut down the weeds before

the seed ripens? The industrious farmers could then take up the battle at home.

Insects

I will mention only the white cabbage butterfly and the Colorado beetle. North and east of Montreal the cabbage butterfly has been extremely abundant. An estimate of forty, fifty and ninety percent can be made of the leaves devoured by the caterpillar in some gardens. In certain places the butterfly could be counted by thousands about mid-August. Many farmers do not wish to go to any trouble and thus allow their cabbages to be mercilessly laid waste. If spoken to about this they reply: "These little beings must eat to live," or again: "You cannot prevent the caterpillar from eating the cabbages." Between entirely preventing and doing absolutely nothing there is room for neglect and ignorance. The answers quoted above are but other ways of saying: "Don't bother me." In reality the person questioned does not know what to do, but in order to learn this it would be necessary to inquire or at least to listen with docility to explanations; and when one has been a farmer or gardener during forty years, is it possible to need instruction in any line? The only means of conducting an effective compaign is by introducing elementary and indispensable notions in the primary schools even if only in the shape of matter for reading.

Near Montreal and in the direction of Boucherville, I have noticed a prodigious increase of Colorado beetles. The unsprayed fields have been completely laid waste. In fields twice sprayed in June and July, I found an average of five larvae and four perfect insects per plant from the first to the fifteenth of August. I questioned a large number of farmers as to the advisability of August spraying. Some hold this to be useless under the pretense that the potato has then ceased to grow. I believe that they are mistaken. Assimilation is still abundant and consequently the leaves are still necessary. Moreover, the number of insects destroyed would well repay the outlay. The name of this insect (potato-bug) leads me to believe that the potato is its favourite plant. Many even believe that this is the only plant which it attacks. On announcing its arrival in Canada, in December, 1870, the abbé Provencher said: "The potato suits these insects particularly, and it seems to be their almost exclusive food." The tastes of this insect have since been better studied. The Colorado beetle seems to prefer the egg-plant. I must confess that I have never seen the two together, but the reason is that the Colorado beetle did not exist or that the egg-plant was wanting where I conducted my researches. Some perfectly trustworthy gardeners, men well-informed, have vouched for the truth of this statement, and I have no reason to doubt their word. This

year I have been able to draw a new conclusion from personal observation, namely, that the Colorado beetle is fond of ornamental tobacco (Nicotiana affinis). In a garden when some fifty plants of this variety had been set, this insect devoured them as greedily as potato plants, attacking both leaves and flowers. The idea then occurred to me that the potato bug might become the bug of all the Solaneœ and this I tried to ascertain. I had at my disposal tomato plants, petunias and ordinary tobacco. A good many persons had assured me that the potato bug does not eat tomatoes. I resolved notwithstanding to extend my experiment to these also. The first tests consisted in transferring eggs, larvae and perfect insects to some petunias, tomato and tobacco plants. The failure was complete, neither larvae nor insects wishing to eat. They tasted the leaf, then departed; the insect undertaking a long journey, the larva generally burying itself in the ground after having explored the neighbourhood. I had taken my subjects now from the potato, now from the ornamental tobacco. I was especially surprised to see that the larvae from the ornamental tobacco absolutely refused the ordinary tobacco; a few of these larvae transferred from the potato to the ornamental tobacco had not seemed to notice any difference, but transferred from the latter to the ordinary tobacco they left immediately. After many trials I concluded that neither the larvae nor the perfect insects attack the petunia, tobacco or the tomato if they are free. The insects coming from eggs hatched on the leaves of these same plants show the same state of mind: they die on the spot if their strength does not permit them to migrate.

I was pleased to see the tomato and tobacco spared. However an important question remained: in case of famine, isolated in a field where they would find no other food would the larvae and the insects die of starvation rather than eat a food belonging to the same family as their favorite food? In the above mentioned experiments where the subjects were given entire freedom, it was impossible to see how hunger would make them act, since all left and soon disappeared. I then made prisons out of boxes and shut up the larvae and perfect insects taken from ornamental tobacco and potato plants. In a few of the boxes I placed petunia leaves, in others tobacco and in the remaining ones tomato leaves. Here is what I observed: The perfect insects, far less greedy, held out very long, walking all over the leaves and examining them minutely. The relatively insignificant quantity which they eat renders the observations extremely difficult. At times they stop and seem to press their mouths upon the leaf but after they leave, no change can be noticed. Have they really eaten? Impossible to decide. I kept a few for three weeks in empty boxes; and they survived. What had they eaten? The boxes seemed intact. The observations were so difficult that

one had to be prudent about conclusions. However by comparing the quantity eaten while at liberty and that taken to escape death in prison, useful information was gathered. Thus, the petunias excepted, the leaves had been attacked. The insect eats very little of the tobacco and tomato, but eats some nevertheless. It is evidently hunger that compels it, since it abstains for five or six days. This fact I have been able to ascertain only with dry leaves. At first I changed the leaves to maintain at least in part the conditions of life in a state of liberty. But these leaves dried up without any sign of their having been attacked. With the dry leaves the perforations were easier to notice on account of the decreasing elasticity of the fibres. Evidently the conditions are out of the ordinary, but a conclusion which has its importance forces itself upon us: The perfect insect which resists famine naturally can prolong its life for a considerable time by taking small quantities of tobacco or tomato leaves. It could then be transported enormous distances in these very leaves and thus spread rapidly. This insect which seems so awkward and heavy, gifted with wings only to drag itself along clumsily would be carried instead of carrying itself. Once arrived at some point, thanks to a wonderful instinct, it would journey towards a potato field which would soon become its property. This would explain its rapid propagation. When it came from Colorado and invaded Canada it advanced at the rate of from seventy-five to one hundred, and even from two to three hundred miles yearly in spite of its clumsiness. Further, it is not impossible that its life can be sustained not only by the tobacco and potato but by other plants as well. This I have not tried. In any case, thanks to our rapid means of transportation, its natural power of endurance insures its propagation. Whither might not those have travelled which lived for three weeks in empty boxes, had they been in railroad cars instead? So much then for the perfect insects.

With the larvae, experimenting is easier, since they must either eat or die, and when they eat one quickly notices it. All the larvae placed in boxes died, the most sturdy living but five days. Scarcely were they placed in presence of the leaves before they tasted them and went away. Those which had petunia leaves absolutely refused to eat and died after two or three days. The others ate some tobacco and tomato leaves, consuming about one third the quantity they would have eaten of their favorite plants during the same length of time. The change did not agree with them; in fact their death was caused thereby. The conclusion seems simple; as long as there are ornamental tobacco and potatoes in the neighbourhood, the larvae will spare the petunias, common tobacco and tomatoes. There is little reason to fear them unless little by little their stomach becomes adapted to the new food. Let us hope that this may not happen.

THE EYE-SPOTTED BUD-MOTH

(*Eucosma* (*Spilonota*) *ocellána* Schiff.)

E. Melville DuPorte, Macdonald College.

The following studies on one of our most injurious orchard pests were made during the seasons of 1914-1916, chiefly on the island of Montreal, but observations were also made in orchards at La Trappe, Como, Abbottsford, Rougemont and Ste. Hilaire, and information was obtained from various sources as to the prevalence of the insect in different parts of the province.

Food Plants

In Europe the bud-moth has been recorded from apple, pear, quince, *Carpinus*, *Crataegus*, *Sorbus*, *Quercus*, *Alnus*, mountain ash, cherry, sloe and larch. Heineman describes a distinct variety *laricana* from the larch.

In America the food plants mentioned are apple, pear, plum, cherry, quince, peach, blackberry, laurel oak. In Quebec the writer has collected it on apple, plum, cherry, pear, wild plums, *Crataegus*, and an ornamental flowering crab. These hosts are given in order of their importance. The insect shows a marked preference for the apple; in young apple orchards with plum and cherry fillers the latter are not greatly injured as compared with the apples. I have failed to find it on the blackberry even when the canes were growing between rows of infested apple trees.

Description

(*Adult Figs. 5 & 6; Larva Figs. 1 & 2; Pupa Figs 3 & 4.*)

Adult.—A small moth with a wing expanse of 14 mm. to 16mm. ($\frac{3}{5}$ inch). Antennae filiform, in the male apparently notched at the base owing to the presence of a slight protuberance at the anterior edge of the fourth segment and a spur on each of the sixth and seventh segments. The head and thorax are dark grey. The basal third of the upper surface of the forewings is concolorous with the thorax. The middle of the wing is cream to grey forming a light-coloured band across the wing, widest at the costal margin. This band is usually mottled with more or less indefinite areas of grey, and its margins are often marked with well-defined small dark spots or vertical streaks. On the inner margin near the anal angle is a large well-defined dark grey triangle. Outside of this is a lead blue vertical streak followed by a usually

well-defined vertical streak of dark grey, the anterior portion with darker horizontal dashes. This is followed by a second lead blue streak. The outer margin is bordered by a dark grey band; the scales fringing it are chiefly dark grey, but a few are lead blue. The under side of the fore wings is ash grey, spotted white along the costal border. The hind wings are ash grey above and below and uniform in colour. The abdomen also is ash grey; in the male slender bearing a small tuft of scales at the anal extremity.

Egg.—The egg is broadly oval, sometimes almost circular, .9 mm. x .7 mm. (1/28 in. x 1/36 in.) It consists of a narrow flattened outer edge, a portion of the chorion or egg shell, closely appressed to the leaf, and within this a somewhat raised central area containing the yolk. The freshly laid egg is transparent and iridescent closely resembling "a minute drop of water or a fish scale." As it grows older it may become somewhat opaque and in the later stages of development it becomes yellow and more distinctly visible.

Larva. First stage.—The newly hatched larva is light green in colour and measures 1.03 mm. (1/24 inch). The head is .228 mm. wide, its colour smoky brown sometimes tinged with purple. The clypeus, labrum and mandibles are reddish brown, the V-shaped epicranial suture is distinctly marked but the lighter coloured lines parallel to it in the older larvae are absent at this stage. The prothorax is as wide as the head, its shield smoky brown but somewhat lighter in colour than the head. The second and third thoracic segments are narrower than the first and are greenish white in colour. The abdominal segments, except the anal, are uniform in width measuring about .18mm. and concolorous with the two hinder segments of the thorax. The terminal segment of the abdomen often appears brown because of the brown excrement in the rectum.

Under a microscope the setae can be made out. They are light brown and have the same general arrangement as in the older larvae. The setigerous tubercles have the colour of the segments on which they are borne and are very indistinct.

Intermediate Stages.—As the insect feeds the width of the body increases, and in two or three days the abdomen is wider than the head. By the third day the body begins to assume a brown colour which gradually deepens. The head and thoracic shield grow darker and the setigerous tubercles become more distinct. The light median line of the pronotum appears after the third moult, and the light V-shaped lines of the epicranium after the fourth.

Last Stage.—The full-grown larva is 12 mm. (½ inch) in length. The head is dark brown to black and shiny, sparsely clothed with light

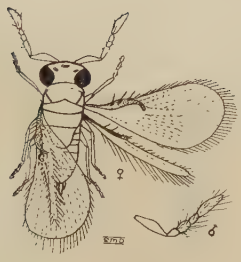
coloured hairs, diameter 1.1mm. (1/24 inch.) The clypeus is often darker coloured. Parallel to the epicranial suture are two thin light coloured lines which meet at the base of the head. The prothoracic shield is concolorous with the head and is marked with a light coloured longitudinal median line. The mesothorax, metathorax and abdominal segments are cinnamon brown and are somewhat wrinkled. The anal shield is usually brown, but lighter in colour than the head and pronotum. The setae are light coloured and are borne on very slightly raised tubercles which are darker than the body. The three thoracic legs are black. The prolegs are borne by the fourth, fifth, sixth, seventh and tenth abdominal segments.

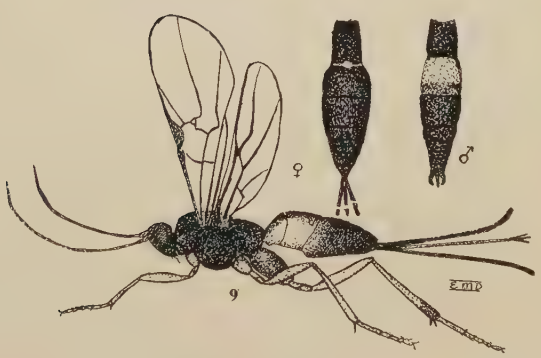
Pupa.—The pupa is about 6 mm. ($\frac{1}{4}$ inch) long, light yellow when first formed, turning to a light brown. It bears a number of scattered delicate light coloured setae. On the ventral side the sheaths of the appendages extend as far as the posterior edge of the fourth abdominal segment. The first six abdominal segments are free. The seventh to tenth are closely united to form a compound terminal segment. The first segment is bare, the second to sixth bear on both anterior and posterior margins of the dorsum a transverse row of numerous very short black spines or tubercles, directed backwards. On the terminal segments there are five such rows, the spines increasing in size towards the anal end. The cremaster consists of a circlet of hooked hairs.

Injury—Nature and Extent.

There is only one brood each year, but the larvae live throughout a portion of two seasons and the injury done by the young larvae in the summer and fall differs from that done by the older larvae in the following spring.

Spring Injury.—During the spring the caterpillars injure the leaf buds, flower buds, leaves, setting fruit and sometimes the young twigs. As soon as the buds begin to swell and the outer leaves of the fruit buds to show green they are attacked by the caterpillars which begin to emerge at this time from their hibernacula. They tunnel into the opening buds either from the top or from the sides. Evidence of their presence in the bud is shown in the brown excrement at the entrance to the tunnel. Within the bud the caterpillar feeds on the developing flowers, destroying all or most of the flowers in a cluster. In one orchard, in which the infestation was comparatively light, eighteen per cent of the flowers were destroyed. In badly infested orchards the percentage of flowers injured is considerably





The Bud-moth—Stages and Parasites (original). 1. Full grown larva. 2. Newly hatched larva. 3. Pupa-ventral side. 4. Pupa-dorsal side. 5. Full grown moth and base of the male antenna. 6. Moth with wings folded. 7. *Pentārthon minutum*, an egg parasite. 8. *Pimpla conquisitor*, a pupal parasite. 9. *Bassus earinoides*, female insect, and abdomens of male and female.

higher. In Nova Scotia Sanders records injury to 59.56 per cent of the blossoms, and in unsprayed orchards in Quebec I have found evidence of injury to more than 50 per cent of the fruit buds.

The injury to the leaf buds is similar to that done to the fruit buds. The buds may be entered a soon as they begin to burst, or when the first leaves are partially or fully expanded. As the leaves expand the insect pulls the softer ones together and fastens them with silk, forming a nest within which it feeds on the more succulent leaves (Fig. 13). Some of the injured leaves die and turn brown giving a badly infested tree the appearance of being burnt.

The losses due to injury of this nature are most evident in nursery stock. The writer has visited nurseries in which a large proportion of the young trees was disfigured and many rendered unmarketable through the destruction of the buds.

After the buds have opened the caterpillars often make their nests by olding the edge of a leaf and lining the tube thus formed with a layer of silk. They usually attach the nest to another leaf and cut through the petiole of the first, which soon dies and turns brown (Fig. 12).

Occasionally such a nest is fastened to a twig, and the caterpillar may bore into the succulent stem and kill the twig above this point. A twig thus injured is shown in Fig. 14. The hole in the twig made by the feeding caterpillar is indicated by the arrow head.

Summer and Autumn Injury

The young caterpillar, which hatches at the end of June, or in July, immediately begins feeding on the under side of the leaf where it makes tiny excavations in the tissue. Soon it builds itself a silken tube beneath which it feeds on the soft green tissue of the leaf, eating through to the epidermis of the upper side which it always leaves intact. The injured leaves are very easily detected by the transparent areas consisting only of the upper epidermis and the smaller leaf veins. These areas are elongated, irregular in outline and may be restricted to one side of a large vein, but more usually spread to both sides (Fig. 15).

Often the caterpillar attaches another leaf to the under side of the one on which it is feeding. In such cases it usually feeds on both leaves, but the two are not equally injured.

The injury caused by the skeletonizing of the leaves in summer may be more or less negligible, but more important direct injury is caused when

the insect attaches a leaf to a fruit, feeding between the two and injuring the surface of the apple. Such apples of course become culls, or at the best number threes.

In the fall this side injury is more pronounced. The caterpillars often bore into the fruit and feed beneath the surface making quite large wounds. The point where two apples are in contact is often chosen by the insect, in which case both apples are injured. (Fig. 16.)

Life History

The date at which the adults begin to appear varies somewhat according to the lateness or earliness of the season. Usually in Quebec the first adults appear about the 20th of June, and the emergence of adults continues for about four weeks. Thus in 1913 the first adult was observed on June 21st and the last on July 21st. In 1914 the first moths appeared on June 20th and one was found in the orchard as late as August 10th. In 1913 the season was almost two weeks earlier than in 1914 and the bud moths emerged correspondingly early, the dates of the first and last emergence being June 16th and July 19th respectively.

Mating and Oviposition.—The moths are quiescent during the day, remaining concealed beneath the leaves until night, when they become active.

Mating and oviposition take place during the night. The female may begin to lay its eggs as early as 24 hours after emergence.

In the orchard the eggs are almost invariably laid singly on the lower surface of the leaf.[1] Only in comparatively rare cases are they laid in small groups.[2]

As shown by the following table the oviposition of a single female is usually distributed over several days.

TABLE I.

NUMBER OF EGGS LAID AND LENGTH OF THE OVIPOSITION PERIOD

	I	II	III	VI	IX	X	XI
2nd day	.....	.....	11	.....	8	45	.....
3rd day	35	.....	0	13	27	46	96
4th day	103	.....	5	60	6	.....	(escaped)
5th day	10	73	21	20	.....	.....	.....
6th day	(dead)	24	6	.....	.....	.....	.....
		(dead)	(dead)				
	148	97	43	93	41	91	96

[1] Theobald states that in England the eggs are usually laid on the upper surface. The tendency to lay on the upper surface is quite marked when the moths are kept in confinement.

[2] In confinement the eggs may be laid in large groups as many as thirty-six eggs have been counted in a single cluster laid by a moth confined in a glass bottle.

The above figures were obtained from moths confined on apple branches by means of large cheese cloth bags. The total number of eggs laid by the individual female probably ranges from forty to one hundred and fifty. The usual number is in the neighbourhood of one hundred.

The life of the adult budmoth is very short. The female dies shortly after she has deposited her eggs. When males and females of the same age were mated in confinement the males usually died before the females.

Development of the Eggs.—The eggs generally hatch in eight or nine days; the writer in the course of his investigations has observed the development of many batches of eggs and in one case only was the period of development slightly under six days. The longest period observed for their development was ten and one-half days.

Development of the Larva.—The larva in hatching eats its way out of the egg shell, which it immediately abandons. It if hatches on the upper side of the leaf it crawls round to the under side. The newly hatched larva feeds for a very short while before beginning to spin its tube of silk, almost invariably next the midrib or some other large vein. The tube is enlarged as the insect grows; the excrement of the larva and the hairs from the leaf are added to the silk.

It is difficult to follow the development of the larva because of its habit of feeding concealed in a tube. In order to obtain material for study the writer mated several pairs of budmoths on a potted apple and placed the latter outside the window of his laboratory so that conditions might be as nearly natural as possible. In this way 150 larvae which all hatched on the same day were obtained, and a few of these were removed each day for study.

The larvae hatched on July 9th; at this time they were 1.03 mm. long and the diameter of the heads was .228 mm. The first moult took place on July 14th. The diameter of the head was then .304 to .342 mm. and the length 1.9 mm. The second moult on July 20th increased the diameter of the head to .39-.437 mm. and the length of the body to 3.04 mm. On July 26th there was a third moult, and some of the larvae moulted for the fourth time on August 13th. It was thus possible to follow the insect through the first four instars during the summer and to ascertain the duration of these instars which was as follows:—first instar, 5 days; second, 6 days; third, 6 to 8 days; fourth, 18 days.

It was more difficult to determine the number of moults in the spring and so the method described by Dyar and previously used by Slingerland in determining the number of moults in the bud moth was employed. It

depends on the fact that the diameter of the heads of caterpillars increases at successive ecdyses in geometrical progression. By measuring the diameter of the heads at different periods in the spring and summer and comparing them with the geometric series of which .228 and .304 are the first and second terms the writer reached the conclusion that there are seven larval instars. The same result was obtained by Slingerland although his measurements were throughout somewhat lower than those here considered.

The following table giving these figures calculated and measured may be of some interest.

TABLE II.

METHOD OF COMPUTING THE NUMBER OF INSTARS OF THE BUD MOTH LARVA

		1	2	3	4	5	6	7
New York, 1893..... (Slingerland).....	By calculation.....	.....	.....	.368	.471	.603	.772	.99
	By measurement.....	.225	.288	.363	.43	.56	.....	1.05
Quebec..... 1914 and 1915.....	By calculation.....	.....	.....	.395	.513	.667	.867	1.127
	By measurement.....	.228	.304	.39	.494	.59	.....	.....
	July and August[1].....	.....	.325	.40	.....	.....	.....	.....
		.....	.342	.42	.....	.....	.....	.....
		.....	.....	.437	.....	.....	.....	.....
	By measurement.....	.....	.325	.420	.497	.573	.821	1.031
	May and June[1].....	.....	.344	.439	.516	.668	.....	1.070
		.....	.....	.....	.535	.726	.955	1.108
		.....	.....	.....	.554	.....	.....	1.146

[1] Each dimension given represents the actual measurement of a large number of caterpillars.

Hibernation.—The bud-moth passes the winter as a half-grown caterpillar. The first cold spell towards the end of September drives the larvae from their feeding nests to seek better protected quarters. It is generally stated that the insect hibernates just beneath the leaf buds. While this is often the case it is not invariably true, for the hibernacula may be constructed in any well protected rough or angular spot on the twigs and smaller branches. Old leaf scales at the base of the buds, rough scars, crotches of branches, any position where bits of bark or scales afford protection, all serve as convenient places for hibernation. From the cankered crotch of a small branch I have collected as many as 16 hibernating larvae. Orchards therefore in which the trees are kept clean or in which varieties with naturally smooth bark are grown offer less protection to hibernating larvae than those in which the bark of the trees is rough.

10

11

12

The Bud-moth—Spring injury to apple (original).

10. The opening of the injured fruit buds.
11. Injury to the setting fruit.
12. Nest of larva on leaf.

13

The Bud-moth—Spring injury to apple (original).

13. Apple twig showing the nests of the larvae.

14. Twig dying as a result of being eaten at its base by the bud-moth larva.

14

The Bud-moth—Summer injury to apples (original).

Fig. 15. Leaves partially skeletonized by newly hatched larvae.

The Bud-moth—Fall injury to apples (original).

Fig. 16. Two contiguous Fameuse apples injured by a bud_moth-larva in the fall.

Fig. 17. The cocoons of the bud-moth (original).

The insect about to hibernate builds itself a small oval silken cell about 4 or 5 mm. long, closely woven and usually completely hidden beneath a scale or piece of bark, which often makes it difficult to find the hibernacula without careful search.

The stage at which the larva hibernates varies. The observations recorded in Table II show that as many as four moults may take place before the larva ceases feeding. Measurements made in May on the heads of hibernating larvae showed that the majority hibernated after the third moult. Some were in the fifth instar, some in the third and a very few in the second. This difference in the stages of the hibernating larvae might be expected if it is remembered that the emergence of the females and the laying of eggs extend over a period of four or five weeks and that there will be a corresponding difference in the ages of the larvae at the time of hibernation.

This method of hibernation was first suspected by Fletcher in 1885 and confirmed by him in Nova Scotia orchards in 1891. In 1893 Slingerland published the results of his researches on the bud-moth which left no doubt as to its method of hibernation. Previous to this time it was generally believed that the larvae fell to the ground with the leaves in the autumn.

Kollar (1840) stated that the insect in Austria hibernates in the egg stage. Theobald finds that in England as a rule the half-grown larvae hibernate, but he has found such small larvae in the spring that he believes some individuals hibernate in the egg stage. Might not these small larvae be some that have hatched late and wintered in the second or third instar as I have found in Quebec?

Emergence of Larvae in the Spring.—The time at which the larvae begin to leave their hibernating nests in the spring depends on the earliness or lateness of the season. Thus in 1914 the first larvae emerged on May 7th, but in the following year when the season was about two weeks earlier they were entering the buds on April 26th. The caterpillars do not all leave their hibernacula at the same time but their emergence extends over a fortnight. Thus, for example, in the seasons above referred to, hibernating larvae were found as late as May 18th and May 7th respectively.

The habits of the larvae in the spring have already been described in discussing the injury done to their host plants. After emergence the larva undergoes three to six moults according to whether it has hibernated in the second, third, fourth or fifth instar.

The oldest larvae are full grown at the beginning of June and the earliest pupae are found during the first or second week in June. The small silken cocoon in which the insect pupates is sometimes constructed within the

larval nest. Quite often, however, the larva leaves its nest and seeks some other place to pupate. A favourite place is at the base of the current year's growth where the old scales and the petioles which here grow close together afford the necessary protection (Fig. 17). Sometimes the axil of a twig serves the same purpose. A wound or a rough place in the bark may also be utilized. Occasionally a leaf is tied to a branch and the cocoon spun between them.

The larvae may remain in the cocoon for several days before pupating. With those studied in the laboratory the period between the spinning of the cocoon and the casting of the last larval skin varied from four to nine days. The pupal stage lasts for eleven or twelve days.

Emergence of the Adults.—The mature pupa pushes its anterior end out of the cocoon. The pupal skin, held firmly to the cocoon by means of the hooked hairs of the cremaster, splits open along the middle of the head and back, and the adult emerges.

TABLE III.

RELATIVE RATE OF EMERGENCE OF MALES AND FEMALES FROM A BREEDING CAGE IN THE LABORATORY

	June											Total June 20-30	July											Total July 1-19	Grand Total
Date	20	21	22	23	24	25	26	27	28	29	30	....	1	2	3	4	5	6	8	10	11	13	14	19	....	....
Males	6	3	4	5	3	6	3	1	5	7	1	44	2	0	1	4	0	1	1	1	0	1	0	0	11	55
Females	1	1	2	3	4	4	4	4	3	4	3	33	1	4	2	1	2	3	2	1	1	0	1	1	19	52

A comparison of these figures shows that the moths are most numerous during the last ten days of June, and that at first the males outnumber the females, but the total numbers of males and females produced during the season are approximately the same.

Natural Enemies

Like most other insect pests the bud-moth is preyed upon by several enemies which help to keep it in check.

Predators.—The larvae are apparently relished by certain birds. Fletcher (1885) quotes a Nova Scotia grower as saying that the birds fed so industriously on the bud-moth in his orchard that he did not observe any of the larvae come to maturity. In England Theobald has observed the

Blue and Great Tits and the Sparrow feeding in the larvae. *Odynerus catskillensis*, a mud dauber wasp, uses the budmoth larvae, along with other caterpillars as food for its grubs. Slingerland found a nest of this insect in which there were six nearly full-grown bud-moth larvae and another larva.

In Oregon Moznette found three predaceous forms, an undetermined carabid beetle, a species of *Triphleps* and a mite *Ancystis agitis* Banks.

Parasites.—Several parasites of the bud-moth have been reported. These are all hymenopterous insects resembling small slender wasps in appearance.

The larva of *Phytodictus vulgaris* Cress, was found by Fernald "attached to the top and across the second segment of the (bud-moth) larva on the outside and entirely out of the way of harm; there it grew fat at the expense of its host which died a lingering death."

Microdus laticinctus Cress, was reared by Slingerland in New York State in 1892. He says "*Microdus laticinctus* seems to be quite a common parasite as Dr. Riley bred it from larvae received from Canada in 1870 and again in 1879 from Washington, D.C."

Slingerland also reared specimens of a species of *Pimpla* (near *P. alboricta* Cress.) from the larvae of the bud moth.

In Quebec the writer has obtained three hymenopterous parasites from the bud moth. These were identified by Messrs J. C. Crawford and A. B. Gahan as *Pimpla* (*Itoplectes*) *conquisitor* Say, (*Microdus*) *Bassus earinoides* Cress. and *Pentarthron minutum* Riley.

Bassus earinoides is a well-known parasite of *Exartema malanum* Fern the apple bud worm. During the summer of 1914 and 1915 this insect was reared in large numbers from the pupae of the bud moth (Fig. 9).

Pimpla conquisitor Say was also obtained from the pupae of the bud moth during the latter part of June and throughout July. The numbers were fewer than those of *Bassus earinoides* and the males were greatly in the majority (Fig. 8).

The most important parasite found was *Pentarthron minutum* Riley (= *Trichogramma pretiosa* Riley). This is one of our commonest egg parasites but has not before been recorded as a parasite of the bud moth egg. The writer has records from Abbotsford, Como, La Trappe, Baie d'Urfé, Ste. Marie and Ste. Anne (Fig. 7).

The parasitized eggs are easily recognized by their deep shiny-black colour. When such an egg is opened a yellow grub or pupa with bright red eyes is found within. Occasionally two pupae are found in a single egg.

The number of eggs parasitized was exceedingly high. In 1914 from July 21st to August 3rd inclusive the writer collected 1359 eggs from orchards at Baie D'Urfé, Ste. Annes and Ste. Marie, and seventy-seven per cent of these had the characteristic black coloration indicative of the presence of the parasite. As eggs parasitized shortly before being collected would not show this black coloration the actual number of parasitized eggs probably exceeded seventy-seven per cent.

CONTROL

In 1893 Slingerland recommended spraying for the bud moth just before the hibernating larvae emerge in the spring when the buds begin to burst, so that the first meal of the little caterpillars would be a fatal one. This method has been advocated for several years but experiments show that this is not the time for most effective spraying. The larvae which emerge before the buds open do not feed on the outside of the bud except for the first few bites necessary to effect an entrance into the bud. Unless therefore the buds are very thoroughly covered with poison the number of caterpillars which escape poisoning in entering the bud may be comparatively large. More important is the fact that emergence from hibernation is continuous over two weeks and the majority emerge after the buds have burst, and do not feed on the outer leaves which alone will have been sprayed.

Spraying Experiments in the Spring.—During the spring of 1915 the writer conducted spraying experiments in a portion of the orchard of Mr. Edward Maxwell at Baie d'Urfé. This orchard was chosen because during the previous year the percentage of bud moth infestation had been exceedingly high.

The orchard was divided into fifteen plots each containing eight trees. Five of these plots were left as checks and the others were sprayed with lime sulphur (sp. gr. .008) to which lead arsenate was added at the rate of five lbs. paste per 100 gallons.

Sprays were applied as follows;—

Spray 1. April 27th. The buds just starting to burst, the outer leaves showing green. The larvae emerging from their hibernacula and entering the buds.

Spray 2. May 4th. Buds expanded. Majority of the larvae entering the buds. Only a few remaining in their hibernating nests.

Spray 3. May 12th. Three or four days before the blossoms opened.

Spray 4. June 3rd. After the fall of the petals.

The results of the experiment are shown in the following tables.

TABLE IV.

PERCENTAGE OF CATERPILLARS IN SPRAYED AND UNSPRAYED PLOTS, JUNE 10TH TO 12TH

Spray	1	2	3	1, 3	1, 2, 3	1,2,3,4	3, 4	1, 3, 4	2, 3	2, 3, 4	Check
Percentage of bud-moths found	16.3	5.8	8.0	6.8	6.1	1.6	3.8	(6.6[1]) 2.5	9.1[2]	2.6	19.3

TABLE V

REDUCTION IN NUMBER OF CATERPILLARS DUE TO THE VARIOUS APPLICATIONS

Spray	1	2	3	1, 3	1, 2, 3	1, 2, 3, 4	3, 4	1, 3, 4	2, 3	2, 3, 4
Reduction per cent	15	70	58.3	64.8	68.4	91.7	80.3	(65.8[1]) 87.0	52.8	86.5

[1] One tree in this plot gave an exceptionally high count, while the others were uniformly low in the percentage of infestation. Including this tree, the average count was 6.6 and the reduction 65.8; excluding it as an abnormal tree, the figures are 2.5 and 87.0, more nearly what would be expected.

[2] The percentage of larvae on this plot was higher than that found on the plots sprayed with either 2 or 3 alone. The probable explanation of this anomaly is that the local area in the orchard was worse infested originally than the other parts of the orchard.

From the tables it will be seen that the spray applied as soon as the leaves were fully expanded was the most effective of any single spray. That applied just before the petals spread was next in effectiveness. The spray applied as soon as the insects began to enter the buds was not very effective. The fourth spray was not used alone but its effect in combination may be seen from the tables.

Where the usual spray calendar is followed there should be little difficulty in keeping this insect in check as the second and third sprays in the calendar correspond to the third and fourth sprays given above, and it will be observed on referring to the figures that these formed the best two-spray combination. These results agree with those obtained by Mr. G. E. Sanders in Nova Scotia.

In 1916 one hundred trees in the same orchard were used in the spraying experiments. Except those that were left as checks the trees were all given two sprays, one about three days before the blossoms opened and one after the petals had fallen.

In the latter part of June the percentage of infestation was calculated and it was found that on the check trees 42.2 per cent of the buds were infested and on the sprayed trees only 8.3 per cent. So that the reduction in bud moth injury brought about by these two sprays was 80.0 per cent, almost exactly the same as in the preceding year.

Spraying Experiments in the Summer.—During the summers of 1914 and 1915 the writer conducted experiments to determine the practicability of applying a spray while the eggs are on the leaf, in order to poison the newly hatched larvae as soon as they begin to feed. Owing to the large number of egg parasites which destroyed three quarters of the eggs, no attempt was made to spray in the orchard and the figures are the results of laboratory experiments only. Fortunately several rather large apple seedlings growing in tubs were obtainable for this work.

In order to ensure the laying of a large number of eggs the branches of these trees were covered with cheese cloth bags into which several bud moths were introduced. After the bags were removed the plants were sprayed with a suspension of lead arsenate in water at the rate of 2½ lbs. (powder) per 100 gallons of water.

In 1914 no accurate record of the number of eggs laid was kept, but it was estimated that at least 80 to 85 per cent were destroyed.

The record for 1915 is as follows:—

June 28th. A. 110 eggs laid.
B. 240 eggs laid.
June 29th. C. 162 eggs laid.
June 30th. Sprayed A. and B. Left C. as check.
July 8th. Eggs on A. and B. hatching and caterpillars beginning to feed.
July 9th. Eggs on C. hatching. Many dead larvae on A. and B.
July 11th. A count of the three seedlings gave the following results:—
A. 2 living caterpillars in their tubes.
B. 6 living caterpillars in their tubes.
C. 155 living caterpillars in their tubes.
On A. and B. there were a few larvae dead in their tubes but the majority had died before having an opportunity to construct their tubes.
July 14th. A. No living larvae.
B. One living larva.
C. All healthy, feeding.

It will be seen that under laboratory conditions the summer spray may be practically 100 per cent efficient. While such a complete success cannot be expected in the field there is no doubt that summer spraying can be used to advantage.

The advisability of applying the summer spray depends on the conditions. In a severe attack when the spring spray has failed to control the pest the application of this spray at the end of June is strongly advised. If it is necessary to spray for apple scab at this time the addition of lead arsenate to the spray is recommended in order to control the bud moth.

Dormant Sprays. Wilson and Moznette in Oregon attempted to kill the hibernating larvae in February and March, 1914, by spraying with distillate oil emulsion, crude oil emulsion and Yel-Ros, but came to the conclusion that these sprays were not efficient against the bud moth.

NEAR RELATIVES OF INSECTS INJURIOUS TO PLANTS AND ANIMALS

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Crustaceans, Arachnidans and Myriapods belong to the great Branch of Animals called the *Arthropoda*, hence are here termed near relatives of insects.

Class Crustacea

Sow Bugs, Pill Bugs, or Wood Lice.—Sow bugs cause considerable injury both indoors and outdoors to young growing flowers and vegetable crops. They occur in dark moist conditions near dwellings, such as cellars, outhouses, about walls, cisterns, water barrels, under boards, stones and rubbish; in greenhouses and rockeries. They usually feed at night. Sow bugs are sometimes injurious in mushroom beds.

The eggs are laid in early summer. The incubation period varies with the different species—in *Armadillium vulgare Latr.* about 70 days. The young are carried in a pouch formed of modified plates on the abdomen of the females. Other species are *Porcellio laevis Latr.*, *A. quadrifrons* and *Oniscus asellus Linn.* They have seven pairs of legs and antennae which are seven-jointed.

Control.—Cleanliness about outhouses, potting houses etc.; the use of baits of sliced potatoes covered with a thin coating of Paris green, or of bran, Paris green, molasses, orange juice; sprinkling or spraying with kerosene emulsion; sprinkling Paris green on the floor of greenhouses and covering it with damp boards; trapping by means of inverted flower pots containing damp hay or moss; flushing crevices, edges of greenhouse beds, benches and ground beneath with hot water or steam; fumigation with sodium or potassium cyanide ($\frac{1}{4}$-$\frac{1}{2}$ oz. of cyanide to every 100 cubic feet of space.)

Class Arachnida

Order Acarina (Mites and Ticks.)—Abdomen unsegmented, sometimes with annulations, without a deep constriction between cephalathorax and abdomen; legs usually well developed; body more or less depressed.

Chief Families and Genera

Eriophyidae.—Elongated annulated forms. *Eriophyes* on plants.

Argasidae.—*Argus*, *Ornithodoros*, on birds.

Ixodidae.—Ixodes, Dermacentor, Rhipicentor, Margaropus, Boophilus, Amblyomma, on mammals.

Dermanyssidae.—Liponyssus, Dermanyssus, chiefly on birds.

Gamasidae.—Laelaps, on Arthropods and mammals.

Tarsonemidae.—Pediculoides, Tarsonemus, man and grain and other plants.

Tyroglyphidae.—Tyroglyphus, Rhizoglyphus, on dried fruits and bulbs and man.

Sarcoptidae.—Psoroptes, Sarcoptes, Chorioptes, producing itch on mammals and birds.

Tetranychidae.—Tetranychus, Bryobia, on plants.

Trombidiidae.—Trombidium, Harvest mites.

(Consult *Handbook of Medical Entomology*, by Riley and Johannsen, pp. 259-273.)

Family—Dermanyssidae (Poultry Mites)

A most common form is the *Chicken-Mite* (*Dermanyssus gallinae DeG.*), a flattened, elliptical mite, with 8 legs, 1/40 inch long, distinctly reddish after feeding.

The eggs are laid in cracks and crevices of the wood or straw of the nests and roosts. They become mature in about ten days. They are most active at night.

Control.—(a) Cleanliness and sunlight, as mites thrive best in damp, dirty houses; (b) remove droppings and all old nesting material; (c) clean and scrub or wash with water all the perches, roosts, nests, floor and walls; (d) spray or paint these with a 5% cresol, or with 3 parts kerosene and 1 part crude carbolic acid, or with kerosene emulsion. Two or three applications are necessary at intervals of a few days.

When houses are whitewashed 4 oz. crude carbolic acid should be added to each gallon of whitewash. It is often advantageous to scatter a mixture of three parts of dry slacked lime and one part sulphur with the doors and windows closed.

Family—Sarcoptidae (Scab and Itch Mites)

The *Poultry Itch Mite* (*Sarcoptes mutans Robin*) produces "scaly-legs" of fowls, turkeys, etc. It may also attack the comb and beak. The disease is contagious. The mites bore under the scales of the foot and leg and burrow deeper and deeper into the tissue, setting up an irritation, frequently a lameness, and sometimes the loss of some of the toes.

Control.—(1) Oil of carraway (1 part to 5 parts white vaseline) rubbed into leg and foot every few days; (2) bathing in warm soapy water and applying sulphur ointment or naphthaline mixed with 9 parts lard, or 5% creolin or zenoleum or vaseline and zinc ointment.

Itch-Mite of man. (Sarcoptes scabiei Latr.)

This pest burrows under the skin where eggs are laid. In about a week the eggs hatch and the young mites become mature in about four weeks. The lesions and blisters formed are very irritating, and the disease may spread rapidly.

Sheep Scab Mite. (Psoroptes communis var. ovis Furst)

This mite burrows under the skin of sheep forming large areas of crust called scabs. From these areas, commonly confined to the neck, back and rump, the wool falls away. The disease is contagious. Each female lays 15-24 eggs which hatch in 2-3 days; the young mites mature in 15 days. (See Farmers' Bul. 713, U.S. Dept. Agr.)

Family—Ixodidae (Ticks)

Cattle Tick. (Margaropus annulatus)

In the Southern States this tick-causes large losses as the agent responsible for the Texas Cattle Fever. It is a dark eight-legged creature. The engorged female drops from cattle to the ground and lay its eggs. The young ticks (seed ticks) on hatching crawl up nearby herbage and drop on the backs of cattle as they brush by. Attached to the skin they feed until they become mature.

Rocky Mountain Spotted Fever Tick. (Dermacentor venustus)

This tick, with others, is able to transmit the so-called "Spotted Fever" of man in the Rocky Mountain states. It is possible that the ground squirrel of the region serves as a reservoir of the virus. The disease is probably transferred through the salivary secretion of the tick. Dr. Hadwen reports cases of "tick paralysis" of man and sheep in British Columbia due to the bites of this species.

D'variabilis is a widespread form, occurring on dogs, cattle, horses and man, but apparently is of little economical importance.

Family—Tetranychidâe (Red Spiders)

"*Red Spider*" (Tetranychus bimaculatus Harvey)

(Consult Bul. 416, U.S. Dep. Agr., 1917)

A common pest in greenhouses on roses, violets, carnations, in the vegetable garden, and on many outdoor perennials, and a serious pest in Western Colorado on fruit trees, in Central California on hops, and in the Southern States on cotton.

Adult.—Color of female variable—rusty green, amber, yellowish, but more often brick red, with pigment blotches in the sides; legs pale amber; palpi pale salmon; body oval, pear-shaped, 1/50 inch long; color of male rusty salmon, body 1/70 inch long.

Eggs.—Spherical; clear becoming opaque; 50–100 eggs laid by each female over a period of 7 to 12 days. Incubation period varies with the temperature—3 to 17 days. Laid singly on the under side of the leaves.

Larval stage.—Six-legged, round and colourless; duration 2 to 17 days.

First Nymphal Stage.—Eight-legged, oval, darker in colour; duration 2 to 4 days.

Second Nymphal Stage.—Females only have this stage, elongate; duration $1\frac{1}{4}$ to 13 days.

Feeding is done by means of sharp, slender, lance-like mouth-parts thrust into the leaf, producing spotting. Fine webs are spun on the under surface of the leaf, and these are probably protective. Reproduction is both sexual and parthogenetic.

Control.—Spraying with water, with lime-sulphur, nicotine sulphate or miscible oil, or fishoil soap, potassium sulphide or kerosene emulsion; dusting with finely resublimed sulphur.

Clover Mite. (Bryobia pratensis Garman)

This is a small red mite about 3/100 inch long which injures the leaves of clover, apple and other orchard and forest trees by puncturing the tissues, causing them to become yellowish and sickly. The winter is passed in the egg stage, and the small round red eggs can be readily recognized in the crotches of fruit-trees. There are several generations in a season. In autumn it sometimes invades houses.

Family—Eriophyidae (Blister Mites)

Pear-Leaf Blister-Mite. (Eriophyes pyri Pgst.)

This mite is responsible for the reddish or yellowish blisters on the leaves of pear and apple. These blisters turn brown later in the season, and badly infested leaves drop. Nursery stock is often badly injured.

The mites live in colonies beneath the epidermis, forming blister-like galls. Within these galls the eggs are laid, hatched, and the young mites grow to maturity. They then leave by a minute opening on the lower surface and go to new leaves where new blisters are started. The winter is passed as eggs beneath the bud scales. The adult mite is white, elongate, four-legged, 1/125th inch long.

Control.—Spray with lime sulphur wash before leaf buds open.

Class Myriapoda

Sub-Order—Diplopoda

Millipedes

Millipedes are often termed "thousand-legs," "galley-worms," or "false wireworms." They sometimes occur in rich garden soils containing much refuse organic matter, and do considerable injury. They attack plants grown from seed, and also gnaw holes in potatoes, strawberries and bulbs.

The eggs are laid in holes in the soil in the spring, and it requires about two years for the young forms to reach maturity. They are night-feeders. The most common injurious forms belong to the Families *Julidae* and *Polydesmidae*. *Julus Canadensis* is dark brown or black above with sides spotted with yellow, and is from 1 to 2 inches long. *Spirobolus* is from 3 to 5 inches long. *Polydesmus canadensis* is a deep brown flattened form. *Julus virgatus* injures lettuce and *J. coeruleocinctus* the fruit and roots of strawberries. The young millipedes have only three pairs of legs.

Control.—(1) Trap with slices of beet or potato; (2) Mix thoroughly with the soil tobacco dust, gas lime (3 tons to acre in fall), or soot; (3) Give the soil a thorough drenching with kerosene emulsion or two or three light dressings of nitrate of soda (100 lbs. to acre).

BRANCH MOLLUSCA

Class Gastropoda

Garden Slugs. (Limax spp.)

Garden slugs are mollusks and not arthropods, but may be treated here. They are frequently injurious in moist situations to garden and greenhouse produce. They dislike sand, sawdust and ashes as these dry up the secretion of mucus. They spend the winter in the ground encased in their own slime. Some species, however, winter in greenhouses and remain active throughout the year. They are active at night, and feed upon green succulent leaves and ripe fruit.

There are three common species: *L. maximus*, *L. agrestis* and *L. campestris*. Slugs differ from snails in the apparent absence of a shell, but in reality the shell is reduced to a thin horny plate embedded in the mantle.

The eggs are large, round, transparent, yellowish, occurring in gelatinous clusters under boards or refuse. They hatch in spring and the slugs become half grown by fall. The adults may live several years. Blackbirds, toads, moles, centipedes, and poultry destroy slugs and snails.

Control.—(a) Trapping by placing out shingles or boards is quite effective. Examine the traps every morning and crush the slugs collected under them. (b) Liming the soil is also useful. (c) If slugs have collected on the plants dust them with a mixture of lime 5 parts and fresh hellebore 1 part. Providing the hellebore is fresh this is very effective and does not injure the plants. (d) Use the bran-arsenic-treacle mash as for cutworms. (e) Broadcast salt at night in misty weather. (f) Use poultry.

BRANCH—NEMATHELMINTHES

Nematodes or Eelworms

Common Eelworm. (Heterodera radicicola Greef)

Eelworms, although not closely related structurally to insects, may be considered here in connection with them. They are common pests of roots and underground parts of plants, producing root-knots, galls and rough warty surfaces. Tomatoes indoors and potatoes outdoors are often injured.

The males are microscopic in size and resemble miniature eels, hence the name eelworms. The females are white and pear-shaped or rounded.

Life-History.—The eggs are oval shaped and are produced by the females in great numbers in the knots or galls. They hatch in a short time and the young eelworms seek new quarters and feed upon the roots of plants producing the characteristic deformities. They may pass the winter in their host, or it may be on other plants. The young forms may even encyst themselves in the soil.

Control.—Infested soil in greenhouses may be sterilized by steam, carbolic acid (1 to 20) or formalin; mix the soil intimately with gas-lime; rotation of crops; summer fallow; plant clean nursery stock.

The following plants are liable to be severely injured by Nematode attacks (Gilbert, Farmers' Bull. 625):—Soy bean, beet, carrot, celery, cow pea, crimson clover, cucumber, lettuce, peach, potato, squash, tobacco, tomato, watermelon; less severely:—alfalfa, asparagus, lima bean, cabbage, sweet clover, cotton, onion, garden pea, radish, spinach, strawberry, vetch. The following plants are largely immune:—barley, corn, grasses, oats, rye, wheat and cow peas (some varieties).

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